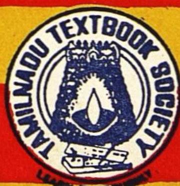
ENVIRONMENTAL STUDIES

HIGHER SECONDARY - SECOND YEAR



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CONTENTS

1. Environmental Quality

We have seen that the environment in which we live consists of land, water, air and living organisms, such as plants and animals. We have also seen that the composition of its elements varies from one part of the earth to another ; plains to plateaus, rainy regions to desert areas ; deltas to rocky regions etc. The complex and sensitive balances introduced by the chemical cycle, which made the earth hospitable to human life, also vary greatly. Therefore the capacity of the physical environment to support living organism, including human beings varies from place to place and region to region. This phenomenon introduces a new term to our knowledge viz. 'quality'. In other words, one can say the quality of physical environment is not the same everywhere. Thus, when the quality varies, we see the variation in nutrient cycles, and living organisms in terms of number of species and size of population. This is mainly because different qualities of physical environment support different quality and quantity of species and organisms. It is also possible that sometimes, the quality of physical environment changes due to human interference. This may result in a series of changes especially in the ecosystem. In case the changes are of very high magnitude, then there is a deterioration in the quality of environment itself.

Man as the cleverest organism learned to modify and to exploit the environment to his advantage. For his basic needs and comforts, he performs agricultural, industrial and urban activities. Thus, he exploits the resources of the earth. But with the advancement of science and technology, man's power to exploit earth resources has increased tremendously. Now he exploits the resources on a large scale not only for his own use but to sell to others for profit. By over exploitation than its production capacity he brings 'quality deterioration'

to the environment. For example man clears forests for firewood and agricultural lands. If such an activity is carried out on a large scale, then evapotranspiration of that particular area will be upset, soil erosion will increase ; the wild animals which have their habitat in the forests become extinct and climate becomes more warm. Thus, the quality of the environment gradually deteriorates. As a consequence of this, one is able to witness the deterioration in the quality of man's life. For instance man's action of clearing forests stimulates the excessive evaporation of water from the soil. This in turn reduces the water table. Coupled with soil erosion and low fertility of soil, the agricultural production diminishes. Thus we will have shortage of food supply and spread of malnutrition, indirectly affecting the quality of life.

With lack of understanding of the inherent processes of the environment, not only does man exploit the resources beyond the capacity of the land but also accumulate large amounts of 'wastes'. The accumulation rate of the wastes becomes greater than that of the absorbing rate of the environment. Sometimes the wastes become 'unabsorbable' by the environment. These products of man become problems to environment. For example by various mining activities, large extents of areas are dug out. After extracting the metals, the wastes are left out in the mining regions. Now, because of this activity of mining, some of the components of the environment are transformed to a new dimension. Biotic environment will take a longer time to get it adjusted with this new physical environment. However, this chain of action makes the environment lose its original form.

Now we realise waste accumulation by mechanical resource exploitation is a major cause of quality deterioration in iron-ore mining and open cut coal and copper mining regions. On the contrary, the resource exploitation by chemical methods is able to produce wastes which are 'unabsorbable' by the environment. For example, various acids, detergents and petroleum products are produced by chemical methods. The wastes as well as products of chemical methods are not absorbable by the environment. They destroy the various components of geo-bio-chemical cycles, They produce such

wastes which are injurious to the environment. For example, sulphur oxide is let out by automobiles by burning petroleum products. This gas is injurious to the lungs and the eyes. Further the mercury and lead deposits from the smokes are

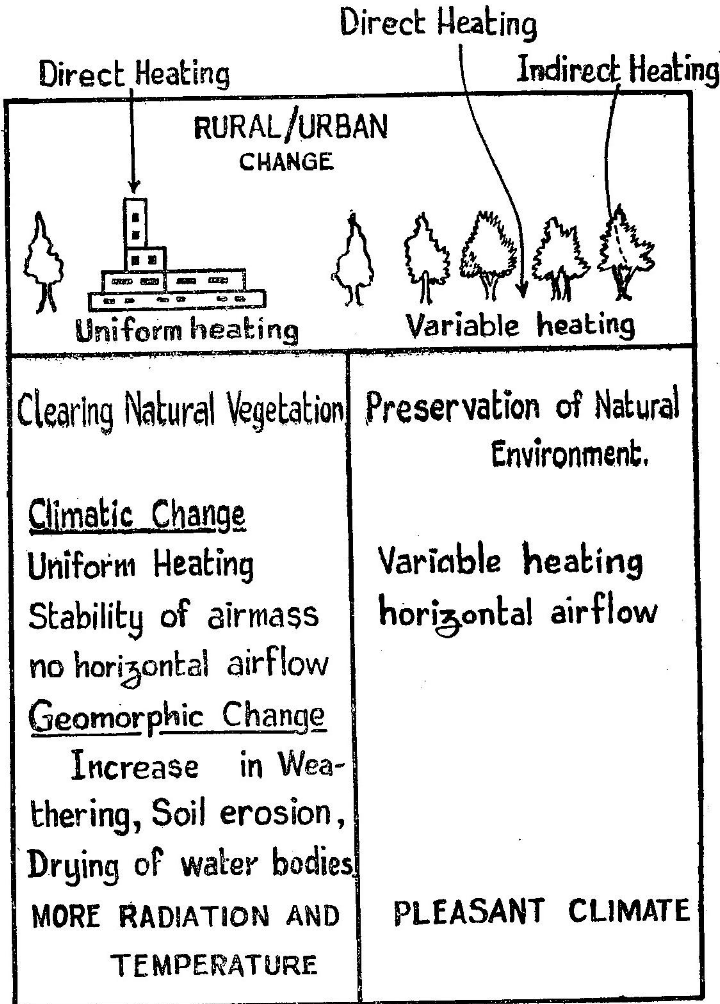


Fig. 1-1

able to stunt the growth of various plants. Chemical wastes from Tanneries and Sugar Processing mills are able to alter

or destroy the natural cycles and bring large extent oı agricultural and wild-life areas into lifeless regions. Therefore the various activities of man, by way of excessive exploitation of resources result in the deterioration in the quality of the environment.

Man's cultural activities to a certain extent can also be considered as a cause for the deterioration of the quality of the environment. For the production of implements and tools and for construction purposes, trees are cut down in the rural areas. This exposes the land to intensified sunlight exposure (Fig. 1.1). Heat radiation of the land increases in areas of human habitation. This has brought in the changes in the microclimate, mechanical weathering, and soil erosion. In such areas the summers are 'hot'. In urban areas this problem is much more prevalent than in the rural areas. For instance, in urban areas cutting of natural vegetation, in the process of construction of roads, highways, tall buildings, sky-scrapers etc., deteriorates the urban climate. All these activities bring a negative impact on the various bio-geo-chemical cycles in those areas. Now even the waste water and urban organic litters are not absorbed by the nature. Therefore there is a water contamination and waste disposal problems. Ultimately the quality of the environment is affected. The following example may give a better picture of the urban environment problem. In Madras city, the Adayar river has a vast flood plain in its lower reaches. This vast flood plain, which is a low lying area has been used by the Housing Board for the construction of multi-storeyed apartments. As a consequence of this, the river has lost its natural flood plain. In December 1978, the excessive rainfall has brought floods in the Adayar river. As a result, the entire flood plain was inundated, including the ground floor of the apartments. Thus, this is a man-made flood hazard in urban life.

Therefore the altering of the environment without understanding the inherent processes is able to bring quality deterioration and hazards. Air and water are highly polluted in the regions where man performs his various activities on a large scale. We know that the quality of air and water supply, definitely affect the health of man. The

gastro-intestinal diseases are highly water-borne diseases. Dysentery, diarrhoea, jaundice, cholera and typhoid spread mainly through water contamination. Influenza, small pox, chicken pox, diphtheria and whooping cough causing germs spread through the air. In densely populated regions the devoid of vegetation makes the air circulation less dynamic. Therefore the outbreak of these diseases is very common. Thus, the interference to water and air circulation due to population congestion is able to bring unwanted health hazards both in urban and rural environment.

It has been proved that the world population is increasing at a very fast rate. But the primary resource necessary for producing food to this fast growing population is land. Recent studies indicate that there are, at most, about 3.2 billion hectares of land potentially suitable for agriculture on the earth. Almost, half of it — most accessible and the richest — is under cultivation at present. The remaining land will

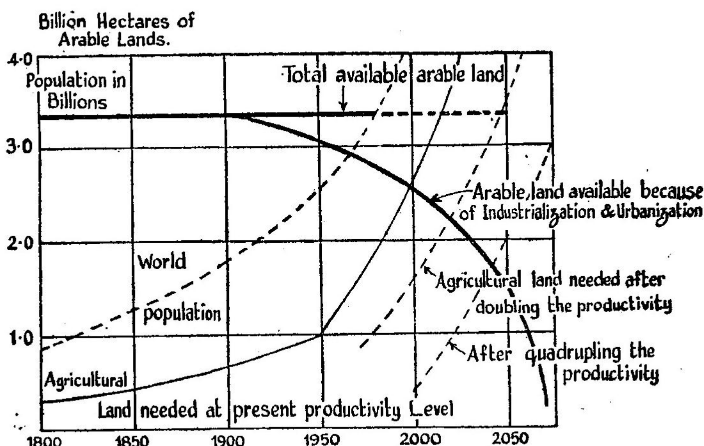


Fig. 1-2

require immense capital inputs to produce food; it may range from Rs. 1600 to Rs. 50,000 per hectare. Apart from this in countries where there is over population, the scope for expansion of agricultural land is limited. The very processes of arable land expansion is itself a problem. We have to destroy other components of natural environment

which will lead to environmental imbalances. Even if the people are ready to pass high capital costs for expansion of arable lands and to bring imbalances to environmental conditions, there is a theoretical limit for growth.

The figure (1-2) illustrates the problem very well. The upper horizontal curve indicates the world arable land availability, which is about 3.2 billion hectares. The arable land needed to support a person is about 0.4 hectares at present. With increasing productivity of the land there is a scope—but only marginal—to reduce the 0.4 hectare limit to 0.35 or 0.3 hectare. The lower curve shows the amount of agricultural land needed to support the increasing population. But the increase in housing conditions, industries' waste dispesal, roads and public structure will occupy the arable land at an increasing rate. Then there will be a loss of arable (potential and developed) land. This can be noticed in the upper curve which slopes downward after 1920 or 1930. This indicates the world is moving towards a sudden and serious shortage of arable land.

Therefore there is a need to rationalize the exploitation of the world's limited natural resources.

Environmental scientists, technologists, nutrition scientists and futurologists are endeavouring to indicate the limits imposed by the natural environment towards which our acquisitively-addicted generation, obsessed by a desire for progress is heading. Today mankind has more and more needs. For instance, in the past, recreation and organised leisure placed no demands on the environment. Now, the pendulum has swung the other way. Frequently, in the neighbourhood of densely populated areas, where raw material questions are of high importance, there are conflicts between diverse requirements of recreation, health and industries. The rapid increase of population and the growing demands on space have caused an explosive acceleration of the attack on nature. This leads us to consider how we can use the space remaining to its maximum without determining the quality of the environment. Adequate planning, technology and predictive thinking are essential, because the properties

we are dealing with are decreasing in quality and quantity. As the potential of our natural environment is not unlimited, experience and intellect have to be applied if mankind is to be capable of mastering the problems of the future. In view of these facts, in the following chapters, we will be dealing with the details of the various problems faced by man in the process of his interaction with environment.

PART-I

Natural Hazards

Nature helps all living organisms in one way or another. For example, sunlight and rain are so essential to all organisms, without which plants cannot grow. Human beings depend partly, if not wholly on vegetation for food.

Not only does nature help all living organisms on the surface of the earth, but it also creates untold misery at times. Therefore the natural hazards include all roots of extreme geographical events like floods, storms, earthquakes, and volcanic eruptions, that have a rising toll of life and damage.

Natural hazards can be broadly grouped into following categories :

(1) Climatic hazards

(2) Geologic hazards

(3) Geomorphic hazards

(4) Biological hazards

These natural hazards are the real problems to environment and man. It is very difficult to predict these hazards sufficiently in advance. However, man can take certain precautions if he knows the basic underlying facts about these great natural miseries. It will also help for proper planning with regard to his shelter and food.

In the following section let us analyse each of the natural hazards.

2. Climatic Hazards

The weather forecast given on the radio tells us, what the weather will probably be for the next day. Climate is the average of the weather conditions at any particular place over all the days throughout the year.

People living in tropical countries where there is a dry and wet season can be sure that there will be no rain for several weeks on end, and the people living on an oasis in the Sahara will be really excited if it should rain at all. There is a place in the Atacama Desert of Chile where it has not rained for a hundred years.

Any extreme variation in climate is likely to cause damage to life and property. There are several types of climatic hazards like

(1) Heat wave
(2) Cold wave, frost, fog and smog, hailstorm and blizzards
(3) Air turbulance
(4) Drought and flood
(5) Tropical cyclones
(6) Wildfire.

Heat wave

According to the Indian Meteorological Department, an area is said to be experiencing heat wave when the day maximum temperature is more than 6°C over the five day normal. Weather reports published by IMD in their Journal, Indian Journal of Meteorology and Geophysics, describe heat waves whenever one such occurs. From the weather reports for summer during the years 1949—1966, table (2.1 A and 2.1 B) is compiled to list the waves that affected different

parts of India. This table brings out the occurrence of heat waves in the west coast during March and April and in Northern and Eastern India during the later part of May and in the beginning of June. The heat waves that affected Bihar in 1958 and 1966 were very severe. It was reported in the press that about 450 people died in Bihar due to heat wave. On June 14, 1966, it was reported that the number of deaths by sunstroke caused by the heat wave were more than 350 in Bihar. The actual sunstroke deaths could be higher than those recorded as such these generally go unreported in rural areas. The total number of such deaths in Asansol-Durgapur area in 1966 was 77. Thus it is very clear that heat wave is one of the important climatic hazards and is dangerous to human beings.

Table — 2.1 A

Number of hot days-Gaya and Jamshedpur experienced during the years 1945 to 1960

Years	Gaya	Jamshedpur	Years	Gaya	Jamshedpur
1945	70	69	1953	86	85
1946	51	36	1954	84	68
1947	82	72	1955	78	76
1948	85	74	1956	59	48
1949	61	35	1957	76	72
1950	65	58	1958	100	81
1951	71	57	1959	67	47
1952	72	49	1960	75	69

	Gaya	*Jamshedpur*
Total	1182	976
Mean	74	61
Calculated value	68	59
% of differences	-8%	33%

Table — 2.1 B

Heat waves that affected different parts of India

Years	Date	Area affected by Heat wave	Record Temperature			Departure from Normal in °C and date
1949	June 17 to June 24	U. P., Eastern M. P., Gangetic, West Bengal	Varanasi	45°C	(113°F)	+ 9 June 23 and 24
			Kanpur	46.6°C	(113°F)	+ 9 June 23
			Jhansi	43.9°C	(110°F)	+ 5 June 23
			Ambala	45.6°C	(114°F)	+ 8 June 23
1952	April 13 and 14	Coastal areas of Maharashtra and Gujarat	Bombay	37.8°C	(100°F)	+ 7 April 13
			Surat	37.8°C	(100°F)	+ 7 April 14
			Veraval	41.1°C	(106°F)	+ 11 April 14
955	April 16 to 18	Coastal areas of Maharashtra and Gujarat	Veraval	41.7°C	(107°F)	+ 12 April 20
			Dwaraka	39.4°C	(103°F)	+ 10 April 18
			Bombay	40.6°C	(105°F)	+ 9 April 16
1966	End of May to middle June	Northern and the Eastern India; the area extending from Delhi to Burdwan	Allahabad	43.3°C	(119°F)	
			Banaras	47.8°C	(118°F)	
			Lucknow	44.4°C	(112°F)	
			Durgapur	49°C	(121°F)	

Source : Weather Reports published in the Indian Journal Meteorology and Geophysical and Press Reports.

Table - 2.2

Details of storms

Date of occurrence	Place of crossing	Details of damage
1-12-1955	Rajamadam (Thanjavur Dt.)	A huge tidal wave entered the land to an extent of 30 kms, damaging large stretches of salt pans near Vedaranyam. This caused the death of about 200 persons, thousands of cattle and property worth of several lakhs. Communication was dislocated all along.
23-12-1964	Tondi	A storm ravaged all along the coast of Ramanathapuram and Thanjavur District and strong winds and accompanied tidal waves submerged almost the who leisland of Rameswaram. Due to the devastation, a portion of the island was washed away and passenger train carrying passengers from Rameswaram had been swept away.
5-11-1966	Cuddalore-Madras	During this cyclone the Madras Harbour was affected more. Three ships were drifted ashore; two of them were grounded and one of them was lashed to the break water region of the Harbour and split into two. This cyclone caused damages all along the North-Coast of Tamilnadu.

11-11-1977 Nagapattinam	A cyclone struck the mouth of the Cauvery near Nagapattinam with a wind velocity of 100 km. per hour. This cyclone travelled along the Cauvery river upto Tiruchirapalli Town. During that period strong currents of wind and heavy rain caused hazards to this stretch of Cauvery region and its vicinities. Thanjavur, Tiruchirapalli, Pudukottai, Madurai, Ramanathapuram and South Arcot Districts were greatly affected. Due to the heavy rain there was heavy flooding in all the rivers of the region. Flood waters submerged wide areas of paddy, sugarcane and other agricultural crops and entered into the residential areas of many towns of these areas. In Madurai District the recently constructed Kodayar Dam was washed away by the flood waters. Loss of lives, animals and properties was heavy.

Cold Wave and Frost

Normally the dry polar winds enter into continents during the winter season. During this period, the cold Northerly winds freely sweep towards the south. This is more so in U.S.A. and China. In India, the Himalayas protect the Great Gangetic plains. However, sometimes, the Northerly winds from the Himalayas blowing south causes a cold wave with a sudden drop in the temperature with as much as 10°C. On account of this, ground temperature is likely to fall below freezing point. This type of cold wave is an important natural hazard especially in the Indo-Gangetic plain. Cold waves may also set in as a result of the subsidence of cold air and

resultant inversion of temperature. Every year in places like Delhi, Lucknow, Varanasi and Patna several cases of deaths due to cold wave are reported. For instance, in December 1978 in Bihar nearly 19 persons died of cold wave. The death due to extremity of temperature has become a repeated natural hazard.

Frost

We have already defined the frost in the restless atmosphere chapter. This climatic hazard affects crops. In India during winter especially at the time of cold wave, we get wide-spread frost which damages crops.

Fog and Smog

When damp air is cooled sufficiently that is below its dew point, some of the moisture in it condenses to form tiny visible droplets. If the cooling takes place immediately above earth or the sea, these water droplets will form a fog or mist. So a fog is likely to form if the air is damp and the earth becomes very cold at night, or if warm damp air comes over a cold sea current or over land that is already cold.

Clouds help to keep the earth warm at night and so fog is likely to form on a cloudy night. Wind soon sweeps fog away and generally the windiest places have the least fog. Smog is a lighter form of fog. This is also likely to affect the air traffic. Fog is usually present during dawn and dusk. These natural factors sometimes become hazards for man's daily life. For example in December 1978 the normal air services were disrupted at Delhi Air Port for three hours due to fog which gave poor visibility. Sometimes the fog does not allow the polluted lower layer air to go up which leads to smog in these areas. In our Madras city in October 1972 the fog was heavy in the early part of the night, the smoke from houses, automobiles and the crackers (being Deepawali season) was lingering at the lower levels all over the city which gave irritation to the eyes to many and the air services were affected.

In and around great cities like London and in areas where there are many factories, fogs are usually dark, not

white as they are over the sea. A big city fog is specially harmful to any one suffering from any chest trouble.

Fogs, whether on land or at sea make travel dangerous and slow. Every ship has its fog horn and special devices are needed to keep railways running. Road services are often stopped altogether and aircraft grounded. But aircraft using airfield in thick weather rely chiefly on radio, radar, powerful lights and automatic landing systems.

Sea fog persists for upto 120 days in a year on the Grand Banks off Newfoundland. London has twice been set by 114 hours continuous fog from 26 November to 1 December 1948 and 5-9th December 1952.

Hailstorm

It consists of little falls of ice falling like rain. These hailstorms are formed in thunder clouds. Hailstorms occur on the thundery weather of hot summer, but the violent winds behind a depression may give hail at anytime of the year. Sometimes hailstorms are very large and may reach the size of tennis balls and weigh half a pound. In countries with warmer climates, poultry and even cattle are battered to death by big hailstorms and sometimes people have been killed. It beats down crops such as wheat, cotton, and tobacco and may strip trees of their leaves. Severe hailstorms may break the glass in greenhouses and windows and dent the tops of motor cars and even metal roofs may be torn. Large hailstorms may seriously damage aeroplanes.

Blizzard

The term has come to be applied to any high wind accompanied by great cold and drifting or falling snow, especially in the Antarctic, where however, the blizzards often cause a rise of temperature by removing the surface layer of very cold air formed during calms. Normally we find such hazard in the high ranges of Himalayas. We have several cases reported during the Himalayan Expedition by several mountaineers.

Air turbulance

Sometimes in the atmosphere. the air-flow may attain turbulant character. This may be due to the movement of air and in different velocities through different layers of the atmosphere. Thus this affects the wind speed in the upper atmosphere which in turn is likely to create problem for the air-navigation.

Tornado

The strong wind is a natural factor. Sometimes this becomes so strong and sudden, that it brings· destruction to that part of the country. In 1977 the tornado affected the south part of Delhi, when many buildings collapsed and many people died who were dragged with the wind and killed.

Droughts

Droughts due to the erratic nature of monsoon, with long spells of dry weather and high temperature occur in some or other parts of India every year. Droughts are one of the most serious natural hazards to mankind. They have been the root causes of famine in many parts of the world and more so in our country. Drought is a relative term and normally varies from region to region, mainly measured through water-balance criteria. Historical evidence has pointed out that our country has been affected by famines in 1877, 1899 and 1918. On an average, one year in every 5 years is a drought year. The highest drought frèquency in India occurs in the low rainfall areas of Rajasthan, Haryana, Madhya Pradesh, Central Karnataka, West-Central Tamilnadu and Andhra Pradesh. During 1973 the drought affected 20 crores of human population and it amounted to the loss of 1558 crores of rupees to the agricultural sector alone. The last major famine in India took place in 1943 (West Bengal) when an estimated number of 4 lakh people died of hunger.

Floods

Floods are another disastrous outcome of the erratic behaviour of rainfall. Floods happen when the ordinary channel of a river cannot carry away all the water entering it. This

may be because the channel is blocked, but it is more often caused by too much water.

In cold lands the rivers often freeze over in winter, and sometimes their upper courses freeze more than before those near the mouth, so that ice jammed in the lower river blocks the channel and the water cannot escape to the sea. A river mouth may also be blocked if it is allowed to become choked with mud and not cleared out by dredging.

Too much water can be caused by heavy rainfall or the melting of snow or both together. If the thaw is sudden the rise may be enough to cause damaging floods, especially if there is heavy rain immediately following the thaw.

The sea can cause flooding at the times of the spring tides especially when the sea level has been raised by very high winds. The high tides are then called 'storm tides'. Tidal waves in the sea made by earthquakes can also cause floods as happened in Lisbon.

In India it is the erratic behaviour of monsoon which causes floods in low-lying plain areas and river valleys. This is more so in the basins of Ganga, Jamuna, Ghagara, Gandak, Brahmaputra, Mahanadhi, Godavari and Krishna. About 60% of the floods in India is attributed to the two great river systems namely Ganga and Brahmaputra. Sometimes, cyclonic rainfall also causes floods.

Flash floods

Few deserts in the world are entirely without rain or water. The annual precipitation may be small 5 to 10 inches and comes in irregular showers. But thunder storms do occur and the rainfalls in torrential downpours, producing devastating effects. A single rainstorm may bring several inches of rain within a few hours, drowning people who camp in dry desert streams and flooding mud-baked houses in the oasis. As deserts have little vegetation to protect the surface soil, large quantities of rock wastes are transported in the sudden torrents or flash floods.

Tropical cyclones

We have already discussed how tropical cyclones are found, in the earlier chapters. These tropical cyclones cause enormous damage to people, property and land. Tropical cyclones create two important phenomena.

(a) very high winds
(b) very heavy rainfall.

Apart from the fact that it brings good rainfall, these cyclones commonly known as depressions, are one of the severe natural hazards, especially in India. In Asia, they are called typhoons, and in West-Indies as hurricanes.

Tamilnadu, being located in a highly vulnerable part of the Peninsular India, is frequently subjected to overwhelming devastation by natural hazards due to the cyclonic storms and flooding in its coastal districts. It also experiences severe droughts chronically in some areas. Therefore cyclone as a major natural hazard is a permanent problem in the tropical countries particularly in the monsoon regions and tropical lands near the seas. If sufficient warning in advance is given it is possible to reduce the damages by the cyclone; otherwise avoiding cyclonic storm is beyond the scope of present scientific knowledge.

Wildfire

Normally litter of the forest plants such as dry leaves, barks and twigs accumulate during autumn and summer. During this time even a spark of fire is able to bring devastation to the forest plants and its associated eco-system. In Taiga regions the winter cold is able to bring drying effect on the plants (dehydration). After the winter compartively the plants are susceptible to fire. There are a number of factors which can cause forest fire. Wild fire is normally due to lightning and thunder, volcanic eruptions and rubbing (friction) of certain wild plants against one another.

The hazard is one of the important problems in Canada, Norway, Sweden and the United States. In these countries they have special forest-fighting squads to protect the valuable resourceful forests against this hazard. The death due to lightning or charring wood is not unknown to us.

The areas of volcanic eruptions are highly susceptible to wild fire. When volcano erupts it throws away balls of molten material which is able to cause fire to far away places. Even it is not a violent volcanic eruption the lava flow to the adjoining region is able to spread fire. This kind of damage is quite common in the volcanic regions of Africa, Europe, many of the Pacific Islands and North and South American regions.

Bamboo is able to induce forest fire when rubbed on one another. Bamboo is a common forest plant in Savanna region and open forests of monsoon and other tropical regions. These areas are susceptible to wild fire. Mudumala wild life area in Nilgiris is one of the regions of this kind.

3. Geomorphic Hazards

The landscape on the surface of the earth is the product of the geomorphic processes. These processes are both constructive as well as destructive and hazardous. Landslides, coastal erosion, changes in the course of river and desert creeping or wandering of sand dunes are considered to be the most hazardous among the geomorphic processes.

Landslides

Landslides are those types of movements that are perceptible and involve mass movement of earth debris. These take place when the loosened debris slide down deep slopes. The place where it occurs may be cliff faces, mountainous slopes, embarkments, valley sides, road and railway cuttings. These are caused by the lubricating action of rain water and the pull of gravity which results in slumping or sliding. Landslides are very common on the sides of railway and road cuttings. In some regions frost action speeds up this process. Frozen soils and sub-soils on steep slopes become unstable when the thaw and the movement of water down the slope together with the pull of gravity trigger off a landslide.

Hazards due to landslides are common in hilly areas of Tamil Nadu especially when monsoon is at full swing. For instance the death roll in landslides in the recent monsoon rain (Nov. 5th, 1978) in Ootacamund has been atleast 90 persons. These heavy landslides have disrupted through communication between Mettupalayam and Coonoor. Several houses collapsed and properties were damaged due to these landslides.

Based on the type of movement, relative rate, and kind of material involved, landslides can be classified into five main types:

1. Slump
2. Debris loss
3. Debris fall
4. Rockslide and
5. Rock fall

Many of world's largest landslides have been in combinations of rock slide and rock fall. Land slides into fiords, rivers lakes or resesvoirs, sometimes produce enormous waves capable of demolishing water front villages or doing extensive damage even from considerable distance.

On the night of October 9, 1963, probably the largest land slides in Europe occurred near Belluno in northern Italy. Here, about one-third billion cubic yards of rock and earth almost filled the reservoir. The water which rushed through the mountain claimed 2200 lives in nearby village. Landslides caused by earth-quakes in the Kansu provinces of China on 16 December, 1920 killed 200,000 people.

In December 1840, a hillslide near Nanga Parbat resulted in the formation of a dam 300 m. height. After 6 months the dam gave way resulting in a flood washing away many villages. Similar floods also occurred in 1933 and 1858 in the Indus. A flood in 1863 nearly washed off more than 1000 acres of forest lands in Sind. Similar floods by landslide occurred in the Ganges in the year 1893. Landslides due to earthquake occurred in North Bihar in 1934 and 1950 in Assam.

In the first week of November 1978, a big landslide resulted from heavy rains in the Nilgiris of Tamilnadu, claiming more than hundred lives and resulting in heavy loss and blocked transportation.

Some of the basic measures for prevention and control include excavation to remove fallen or unsuitable materials. Thus the stable material will be more safe from the point of view of landslide. Warning devices are sometimes used to close rail-road blocks when rocks or debris slide over the rail or roads.

Coastal Erosion

Waves, particularly storm waves and tsunamies, are the most important agents of coastal erosion. It is the corrosive or

abrasive action of sand, gravel, and pebbles moved by waves against the shore. Thus coastal erosion produces tremendous geomorphic hazards.

For instance in South India along the east and west coasts heavy coastal erosion results in the uprooting of coconut gardens fishing villages, cultivated lands and good coastal highways. For instance for the past one year the waves of the seas are eroding slowly the breadth of the shore. In the vicinity of Madras city, the coastal erosion is very extensive on the northern side of the harbour, that is from Kasimedu to Ennore. It is possible, if the present condition continues the whole Ennore High Road running along coast will disappear and it will also cause heavy damage to the fuel pipes, carrying the oil from harbour to Madras refineries.

Towards the south of Madras city especially near the Foreshore Estate a severe coastal erosion has occurred during November 1977. It has damaged a part of concrete road running along the coast. If it were not prevented the parts of residential sectors of Foreshore Estate would have been damaged.

The worst thing happened by coastal erosion was along some parts of Kerala coast during 1977. The vigorous wave triggered by cyclonic winds washed out thousands of coconut trees and several villages near Calicut. Similar hazards rae still happening and causing damages to properties in Bombay and in some coastal districts of Gujarat.

Changes in the Course of River

The varying volums of flow in the river and unequal slope initiates the changes in the course of river. The change has tremendous hazardous impact on the adjoining settements and the nearby cultivated areas.

The river Ghaghara, in the middle Ganga plain is highly notorious for its floods and changing courses. This has resulted in rendering vast agricultural tracts into sandy flats. Kosi river in the eastern Nepal deposits infertile sediments of sands and changes vast fertile lands into sandy or marshy flats. The Kosi project is an attempt to tame the river. The Son in lower Ganga

plain also famous for its changing courses in the past, as is traceable from several old beds on its east, but has been tamed squarely with the anicut at Pehri. These rivers have shifted their courses frequently covering wide areas through the historic time as is reflected by the remnants of their former beds in the form of ox-bow lakes, meander loops, dead arms, tals and ruins of settlements, etc.

For instance, the Ganga has shifted over 35 km. between Bhojpur tal and Surha tal causing changes in the site of Ballra. Towns and river parts like Gola, Barhaj etc,, have been affceted by similar shifts of the Ghaghara. The Kosi, has marched about 120 km. during the last two hundred years from near the town of Purnea upto the Tilguga within Durbhanga District. Historically, it has oscillated from the Brahmaputra to about the Ganga-Gandak confluence. Hence the devastations to life and properties due to these were unthinkable.

Sanddunes and Creeping Deserts

Sand dunes are composed of coarser material. Usually sand dunes occur within the desert margins. It is a mobile mound driven by wind action. Dunes develop where the velocity of sand driving winds is checked or reduced often as a result of topographic barriers, vegetation or man made obstructions. Dunes possess gentle slope on windward side and steep slope on Leeward side, It is generally crescent in shape.

All the desert areas of the world have dunes. The most extensive dune areas occur in the great Sahara and Arabian deserts, where 30% of surface is covered with sand dunes. Some complex dunes in southern Iran rise about 60 mts. above their bases. The great sand ridges of the Egyptian desert are as much as 40 mts. high and 290 kms long. The Australian sand ridges are 10-30 mts. high and frequently 160 kms or more in length. Sand dunes of various sizes are common in the margins of Rajasthan deserts of India.

Creeping of deserts as a world wide phenomenon affecting all the continents of the earth and gradually decreasing the natural resources of land. It is because of migration of sand

dunes activated by wind speed. It takes place in the early stages of dune development.

More than a third of the earth's surface is desert or semi-desert. Many of these areas which are now under sand, were once supporting flourishing civilization. The desert is produced as a creeping monster, steadily advancing to snuffout vegetation and eventually to reduce the earth to a vast expanse of sand.

The deserts on the run have encroached extensive arable lands on their margins. The sand dunes in the great Rajasthan desert of India constantly moves eastwards absorbing 800 sq. km. of crop land every year. A quarter of the area of the inner Mongolia is covered by vast stretches of sand. Sand is everywhere and not a blade of grass or sign of human habitation. When the wind blows, clouds of swirling dust darken the sky. Man cannot tame these sands. At present an attempt is made to restrict the advance of creeping deserts and to alter the covered surface. The yields in the margin land shrink to a minimum under the sand incursions.

The United Nations Conference on Desertifications discussed the global problem of regions. The U. N. Brochure says that of the 45 identified causes of desertification only 13 percent are due to natural changes. 87 percent can be traced to human mismanagement of soil, water, energy, flora and fauna.

In arid climates afforestation may be the only way of keeping land in production. Protective plantations are the only effective defence against erosion by wind, dust, storm and desertifications. If the desert areas such as the Rajasthan, were planted with a vegetation cover which had a low water requirements, the clouds of dust would settle in time and the continuous development of the desert climate would break-down. This area, despite its low unreliable rainfall could then revert to its proper role as grazing for the sheep and goats of nomades.

4. Geologic Hazards

The geologic hazards are noticed all over the world due to the following factors :

(a) Disturbances in the structural and tectonic settings of the underlying rocks.

(b) Interference to topographic configuration.

(c) Differential properties of earth materials (rocks and soils) and

(d) Changes in hydrologic regime (surface waters anp ground waters).

For instance, the structural and tectonic settings of the underground rocks means, how rock beds are arranged below the surface of the earth ? What type of rocks are they? How hard or soft are they ? What is the temperature condition? How are these rocks formed ? Are those rock beds joined together strongly or loosely ? These are all the problems which one has to understand before recognising the geologic hazards. Earthquakes and volcanoes are the two important natural hazards under this group. The major causes for earth-quakes and volcanoes have already been dealt, with in the previous sections.

In the case of topographic configuration we have valleys slopes, hills, etc. Steep slopes of the valleys or hills may act as natural hazard for human occupation.

Similarly, the various properties of the soil and earth materials may also act as hazards for human habitation. For instance, let us take a construction in a place where clay is dominant. The clays that were dry during construction absorbs water from rain and expand. Suddenly subsidence may occur under soils. Major structures can fail in a variety of

ways if modes of weakness have not been diagnosed correctly during construction of foundations.

Hazards associated with surface water conditions include flooding along streams and rain erosion and gullying of certain slopes and standing water hazards in areas of improper drainage.

It is rather difficult to identify only natural geologic hazards. There are geologic hazards as indicated above, which are natural, but occur, after humam beings have occupied an area for habitation purpose or certain activities. This cannot be completely dealt with under man made activities. This can be explained in the following manner. Let us take an enormous reservoir, which is constructed in a structurally complex area. In course of time, due to impounding of water for a long period and under great stress, we may get dangerous load-stress effects. This may result in a seismic activity like earthquake. This earthquake in turn may affect the entire area. Thus this natural hazard of earthquake can also happen due to the activity discussed above.

Therefore it is but appropriate to discuss the hazards which are due to earth materials, but activated due to human activities. This can be studied under pollution due to mining activities. At thè end we shall discuss the important natural hazards like earthquakes and volcanoes.

Hazards Due to Mining Activities

Commonly, vegetation is killed for a considerable distance by active smelting in and around mining areas. Around the smelter near Kellogg, Idaho, U. S. A., there is an area of 5 km. in diameter, which has been completely denuded and has stunted sharbs and small trees. A similar picture can be observed in most of the smelter and refinery environs.

Normally it is found whenever the mining activities are carried out the waste materials are dumped in nearby areas. If the contents of these waste materials cannot be readily absorbed by the environment they are likely to create problems to health as well as to cultivation. For instance in 1900, in Montana

(U. S. A.) several hectares of natural vegetation were contaminated by arsenic and copper smelting activities. It is interesting to note in these areas the hay for cattle contained as much as 1800 ppm copper. It was also observed even onions which were grown about 2 to 3 kms from the mining areas contained cadmium, which is hazardous to health.

Another good example can be suggested from Neyveli in Tamilnadu. After the lignite is mined the waste material that are dumped in the nearby areas affected large areas of agricultural lands reducing the fertility of the soil. It was also reported that constant pumping of underground in this mining area likely to stimulate the intrusion of seawater into freshwater areas.

In Bihar, where coal mining is carried out well below the surface of the ground sudden collapse of roofs and gushing of water have created hazards to the minerals and miners.

In Bailadilla and Kudremuch regions where iron ore mining is carried out, large amounts of dust settle down over extensive vegetation areas. This again affects the vegetation. People living around these places face health hazards.

Bed Rock Having Deleterious Effects

Bed rocks are normally continuous solid rock which everywhere underlies loose soil and surfacial rock and which has not been transported since its formation. These bed rocks contain several minerals of different properties. Sometimes some of these minerals acting with water are likely to produce solutions which when consumed will be hazardous to health.

For instance when well water is drawn from an area where floride content in the bed is more, it is likely to affect bone joints of human beings and animals. Similarly excessive calcium content may result in the excessive growth of hairs. Salt contents in the bed rock may produce brackish water in extensive areas which in turn affects the crop yields and plant growth.

It is very interesting to note the deposited materials along the beach might contain radio active minerals. In course of

time these minerals may pose a problem to human habitation. For example, we have wide sandy stretch on the south-west coast of India (250 km. long and 500 mts. wide) extending from Kerala to TamilNadu. This stretch contains radio active monozite-thorium minerals. These deposits are mixed with ilmenite, rutile, sillimanite and zircon. This combination is common in a 55 km. strip between Quilon and Alleppey. Here the thorium content ranges from 8 to 10. 5%, the highest in the world. Continuous exposure of these materials is likely to affect the biological system in this area.

Carcinogens

These are the cancer causing substances of agents. The list of metals which has been reported as potential carcinogens includes : Al, G, Fe, Ni, Cu, Zn, As, Ag. Sn and Pb. Although there is no substantial evidence that copper can cause cancer, a high incidence of lung cancer has been noted among copper-smiths. Both asbestos miners and men working with insulation materials have an unusually high incidence of cancer. Asbestos although containing substantial amounts of oil which can be tumor-promoting, also contains both nickel and chromium. Evidence now is accumulating that asbestos may serve only as a carrier of the carcinogenic metals.

It is reported that the mortality rate of cancer patients is significantly high on the Tamar valley (England) where the vegetables especially lettuce carry high proportion of lead and Copper. This indicates the soil in that area contains a good amount of lead and copper. So far we have discussed the indirect source for geological hazards. Now let us discuss the important direct sources viz. earthquakes and volcanoes.

Earthquake

Earthquakes rank high among natural disasters. An estimated 830,000 people were killed as a result of the Shenshi, China earthquake in 1556; approximately 143,000 died in Tokyo earthquake in 1923; and about 160,000 died in 1908 due to earthquake in Messina, Italy.

The study of earthquake is known as seismology and the instruments used to record vibrations are called "Seismographs". A seismograph is an instrument which contains a weight that is suspended in such a way that it remains still when the ground moves and shakes the rest of the instrument. Inside the instrument are levers which scratch a mark on a piece of smoked paper fixed to a drum that is constantly turning; when the marks become irregular it shows that an earthquake has occurred.

Earthquake shocks are generally most violent near the fault where they occur. They rarely last more than a minute or two but can shake down buildings and sometimes open cracks in the ground. When they occur in cities, the chief damage is often caused by buildings that catch fire or fall and bury people, and by the breaking of gas mains, electric cables and water pipes. When they occur under the sea they often cause great waves, called tsunamis, upto 12 metres high and as mucn as 320 kms. from the crest of one wave to that of the next, which cross the ocean at an enormous speed. At Lisbon, in Portugal, three great shocks occurred on November, 1, 1755. As buildings fell and fires broke out people fled to a strongly made quay, but a second shock opened up a great crack in the quay and all the people on it vanished for ever. Further destruction was caused by tsunamis rolling in from the Sea; 30,000 people were thought to have been killed in this earthquake, which made itself felt as far away as Scotland and Scandinavia.

In Assam, India in 1897, an earthquake laid waste to 380,000 square kms. of land and was felt throughout 10,000,000 sq. km. Huge landslides swept away the soil and forests leaving only bare rock and blocking the valleys. Water logged sands were forced from under ground and spread over the countryside like floods.

Most of the earthquakes are associated with seismic systems namely the Alps-Himalaya great circle and the two great circum Pacific belt. The foci below the epicentres are classified as shallow (50 km. deep) intermediate (50 - 200 km.) and deep (200 - 700 km.)

Effects of Earthquakes can be classfied as follows.

1. They can cause vertical displacement of parts of the crust.

2: They can cause the raising or lowering of parts of the sea floor as in Sagami Bay (Japan) in 1923. This causes tsunamis or tidal waves.

3. They can cause the raising or lowering of coastal regions as in Alaska in 1899 when some coastal rocks were uplifted by 16 metres (50 feet)

4. They can cause landslides as in the Loess coúntry of North China in 1920 and 1927.

5. They can cause the devastation of city fires and diseases.

The following table shows some of the major earthquakes that occurred in different parts of the world,

Table—1

Catastrophic Earthquakes

Year	Place affected	Damage
1556	**Shenshiprov, China**	**8,30,000 killed**
1737	**Calcutta, India**	**3,00,000 ,,**
1755	**Portugal**	**Caused depression of the sea floor near Lisbon.**
1868	Peru	30,000 killed
1899	Alaska	Coast of disenchantment Bay uplifted
1906	California	San Francisco destroyed
1906	Chile	3,000 killed
1920	Japan	Level of Sagami Bay changed and 2,00,000 killed
1927	China	Landslides killed 1,00,000.

1931	New Zealand	Napier destroyed
1931	Nicaragua	Mangagua (the capital) destroyed.
1960	Agadir	Town destroyed and 10,000 killed
1962	Iran	Over 20,000 killed
1970	Peru	Earthquake on 31st May - killed 50,000 and made 10,00,000 homeless
1972	Nicaragua	Managua, the capital devastated and 50,000 killed.

Man's helplessness in the face of earthquake has no parallel. Other natural calamities — cyclone, flood and even volcanic eruption leave at least half a door open for escape to safety. There is very little for man to do when everything around begins to shake and the only way to avoid a burial under crumbling wreckage is to scamper out of buildings to open spaces.

Seismologists believe that the 1897 earthquake was the severest known in Indian history. Its epicentre was on the southern margin of the Shillong plateau on Dawki fault. The tremor was felt over 4.5 million square kms. The north-eastern region was also hit by the quake of August 15, 1950, which is regarded as one of the severest both in magnitude and destructiveness, in human history.

The 1897 tremor, within the space of fewer than 60 seconds, had reduced Shillong, the picturesque capital of Meghalaya, into shambles. The vertical component of the seismic motion was so great that stones on Shillong streets were tossed in the air. The resultant structural changes on the surface of the earth such as fault scarps, fractures, local changes of level, compression of the ground and slight changes in the height of hills, are of great geological significance.

The quake of 1950, in north-eastern parts of India caused huge fissures, discharging sand and water, and subsidence of the

ground in some areas and elevation in other tracts, altering the drainage of the country and causing extensive floods. The floods were greatly accentuated by the bursting of numerous temporary dams as a result of landslides in the channels of the Dihang, Subansiri and other tributaries of the Brahmaputra. Changes in the main drainage line of the river system have over the years caused the problem of erosion as a result of which large parts of Dibrugarh town have been devoured by water. The loss of human lives in 1950 was put officially at 1522. Besides, cattle perished in thousands and nearly 80 percent of the dwelling houses in Dibrugarh and Sibsagar towns were wrecked fully or in part.

Problems in Earthquake Prone Areas

Seismic waves affect different structures in different ways. Houses respond differently from tall buildings, dams, highways and bridges. Wood frame construction, resists earth-quake shaking far better than masonry construction. Like a reed bending and surviving the great storm which blows down the sturdy-and rigid-oak, the wood frame house yields to earthquake vibration without breaking. Brick, and other masonry collapse more readily because they do not yield.

Dams occasionally fail during earthquakes. Earthquakes also damage highways and railroads in many ways. Damage to highways and railroads during severe shock is usually extensive. Oil storage tanks located in dock areas, may catch fire as they did at Alaska in 1964, Here oil caught-fire and added to the damage.

In many earthquakes, damage due to secondary effects such as fire, landslides or seismic sea waves (Tsunamis) far exceeds damage due to direct effects. Vast areas may be uplifted or depressed during an earthquake. Uplift of large areas of seashore in Merrylands accompanied the Alaskan earthquakes of 1964. Most marine organism were killed, but most marine communities re-established themselves within a few years. Subsidence allowed salt water to invade coastal fresh-water marshes and lakes.

Tsunamis or gravity waves radiate in long, low oscillations from Submarine disturbances at speeds of 720 KPH., 780 KPH. The 1883 Krakatoa (Tsunamis) reached a height of 40.5 metres and that off Alaska in 1964 attained a height of 66 metres.

The study of earthquakes, has great relevance for India, because the north-eastern part of the country is one of the most geologically unstable regions of the world. The earthquake of June 12, 1897 which led to the birth of Modern Seismology had its epi-centre in this region.

A system of faults known as the strain boundary fault runs through the mouth of alluvial Brahmaputra valley. Another fault thrust runs east to west along the southern margin of the Shillong plateau and merges with the north-east to south-west thrust in Nagaland and Assam.

Earthquakes of shallow and intermediate focus are associated with high mountain ranges like the Himalayas which owe their existence to large compressive forces. Mercifully, a large part of the region consists of wild forests and rock mountains with little human habitation. This is the reason why in spite of the frequency of earthquakes in the north-eastern region, the loss of life is usually small. The destruction caused by earthquakes depends more on the proximity of the epicentre to human settlements than on their intensity. A minor cause of earthquakes is the movement of molten material, or liquid rock under the surface of the earth in a region of volcanoes such as Hawaii on the North Pacific. Such movements however, do not cause more than slight vibrations-which are known as earth tremors.

Earthquakes are mainly caused by 'faults', in the rocks of the earth's crust. A 'fault' is a break in the layers of rock caused by one mass of rock rubbing on another with the tremendous forces. This great force makes the earth vibrate and the layers of rock on the one side of the fault are pushed upward, downwards or sideways. The fault itself is often deep in the earth and does not show on the surface at all, although it may cause the surface to crack.

The vibrations may be felt thousands of kms. away. These kinds of earthquakes occur in the areas of the world where the mountains are young. There are two great earthquake belts, both of them containing volcanoes "the ring of fire" encircling the Pacific Ocean, and a belt stretching across Southern Asia and through the Mediterranean Sea, with an offshoot through the Red Sea and Ethiopia in the East Africa. In these areas the earth's crust is still in an unsettled state and mountains are still being pushed upward in some places.

Volcanic Hazards

Due to volcanoes the lava flows on the slopes with varying velocities. They cause damage to villages and fields in areas surrounding the volcanoes. The other type of hazard is ash eruptions. Breathing in an ash eruption is like breathing in dust storms. Toxic fumes, like sulphur dioxide causes complications of breathing. Ash can destroy staple crops of a region and can contaminate surface water supply. For example the Costa Rica's Coffee yield was reduced about 10% during the first year of eruption and over 25% in the second year (after 1963).

There is also danger from cloud eruption. These dense clouds of ash and toxic gases flow so rapidly down to slopes of volcanoes that nothing is able to escape from their path. For example in Costa Rica in 1968, cloud eruption killed 78 people and destroyed everything in its path.

5. Biological Hazards

Available evidences indicate that the way in which an eco system operates is much more elaborate than has been thought so far. It is a complex, self-regulatory system where different organisms co-exist, some in large dominant groups and some in small numbers as rare species. In the case of an ecosystem the interrelationship of the components are such that none of these can exist without the others and at the same time each exerts a controlling influence over the others. Some live at one place all the year round and some come and go. There may be fluctuations within the system but the components are usually so adjusted as to remain with certain limited ranges of fluctuation. Thus, hundreds or thousands of varieties of plants, animals and microbes share a place for co-existence unless the human beings who are above this regulatory mechanisms disturb them.

An ecosystem is a boundless system. On any part of the earth the different ecosystems are continuous. The "balance of nature" which is mainly due to the mutual control mechanisms, depends upon the many feed back circuits existing between the constituent organisms or between the many physiological processes in the organism. Under the natural regulatory mechanism no species is allowed to push others aside and proceed beyond the normal limits of proliferation and prosperity. However, it is possible that some of the conditions like food, weather and natural enemies, which control the proliferation of some species would cease to operate suddenly and simultaneously. Such sudden cessation in the operation of environmental factors could also occur due to the unscrupulous interference in the ecosystem balance by human beings. This would invariably cause some species to proliferate tremendously and result in what is known as an "out break". The immense reproductive

potential of animals and plants helps this "out break". Examples for such "out breaks" are found frequently in the population of rats, grasshoppers, imported noxious insects and newly introduced weeds. If there is no further interference, an indirect regulatory mechanism would soon begin functioning to put an end to the "out break" and bring the population back within the normal range of fluctuation.

The major biological factors affecting the population size adversely are (1) competition between organisms (2) ammensalism, and antibiosis (3) Parasitism including diseases and (4) predation. These interactions might frequently occur in any community and may be easily identified. It is also likely that for a given pair of species the type of interaction may change under different conditions or during different stages of development. Thus, two species might be neutral to each other at one time and might exhibit commensalism at another and parasitism at still another time. It is possible to single out and study in detail the different interactions in simplified ecological systems and in well-designed laboratory experiments.

Competition between Organisms

Competition is defined as the struggle for existence which arises when total demands of organisms exceed availability. These demands may be for the different conditions for existence. When the competition is between individuals of the same species it is called intraspecific competition. When it is between individuals of different species it is termed interspecific.

In intraspecific competitions, the chance for survival of one individual over another of the same species depends on the presence in it of characters (inherited or acquired) which help to obtain greater share of available food. Thus, animals that are larger than others in the same litter often have a direct advantage. Similarly, a tadpole that hatches out earlier from a mass of frog eggs will get a **head start in** consuming available food in addition to the mobility that helps it to escape from predators. Again, seedlings obtained

from large seeds possess a greater advantage for survival because of the larger cotyledons and the rapid early development.

Interspecific competition can result in equillibrium adjustments between species or even in replacement of one population with another or in forcing one species to occupy another space or to use another food, depending on the basis for the competition. It is known that closely related organisms do not invariably occupy the same ecological niche. If they happen to occupy the same place they would be using different food or would be active at different times. Thus a species will persist only if its niche is available. If the conditions change a better adapted species may even eradicate the first species. This phenomenon of the ecological separation of closely related species is known as the competitive exclusion principle or Gaure's principle (after the Russian scientist who first confirmed the principle experimentally).

One of the important examples of species occupying separate niches within the same area is found in the intertidal zones at the edges of oceans. A district zonation in the growth of algae is found with the greens, browns and reds occupying areas in that order from high to low tide levels.

This zonation is the result of the different requirements of these species for specific conditions of light, exposure to drying and temperature.

Ammenisalism and Antibiosis

Ammenisalism is the phenomenon where, as a result of interaction, one organism is affected adversely while the other is not affected. A good example is a large animal stepping on and killing a small animal.

When an organism produces metabolic substances which are unfavourable to the growth of another organism, the interaction is called antibiosis. Similarly, the inhibition of growth and development of plants by the production of chemical substances by certain plants is called allelopathy (=harmful to the other).

These are all negative interactions and our knowledge on these is rather incomplete. Toxic substances are produced by many plants and some of these are known to inhibit the growth of the seedlings of other plants (ex. the rhizomes of and roots of some grasses like the quack grass). Some plants are poisonous to animals (ex. the poison ivy : **cannabis**). But in this case, if animals eat these plants both would obviously suffer. Some varieties of cassava (tapioca) produce large quantities of hydrocyanic acid in the tissues and a single feeding is sufficient to kill the animal. The resistance observed in a variety of flax to wilt disease caused by the fungus. **Fussasium** has been shown to be due to the secretion of sufficient hydrocyanic acid into the soil to destroy the parasitic fungus. Many higher plants are known to synthesis substantial quantities of substances repulant or inhabitory to other organisms.

It has been shown that the volatile terpenes produced by many of the aromatic shrubs inhibit the growth of herbaceous plants. The volatile toxins are produced mostly in the leaves. When the fallen leaves decay the toxin accumulate in such quantities that germination or subsquent growth of herbaceous plants during or after the rainy season is inhibited. Similarly, certain other plants are known to produce water-soluble chemicals like phenols and alkaloids on which again inhibit the growth of many herbs. Such allelopathic effects can influence the composition of an ecosystem and also the species sequence of plant succession.

Antibiosis is not restricted to the higher plants. Many micro organisms are also known to exhibit this phenomenon. Some fungi and actinomycetes produce metabolic substances called **antibiotics** to suppress other micro organism. Perhaps, the best known antibiotic is **penicillin** produced by species of the fungus **Penicillium** and this is inhibitory to the growth of a wide variety of bacteria **Streptomycin** is produced by the actinomycetes streptomycse. Many other antibiotics are also known. As far as it is known the bacteria do not affect the growth of the antibiotic producing microbe.

Parasitism and Predation

Generally, in a stable ecosystem the negative effects due to parasitism and predation tend to be quantitatively small. In other words, natural selection and hence evolution appear to result in reduction in the adverse effects or in the complete elimination of these interactions altogether, since continued severe depression of a host or prey population can only lead to the extinction of these populations. Therefore, severe interaction is most often observed only when the interaction is new (when the two populations become associated first) or when sudden changes in the ecosystem occurs (as might be produced by man). This results in what is known as the "principle of instant, pathogens" which explains why man's ill planned introductions commonly lead to epidemics.

There is no sharp distinction between parasitism and predation since in both types of interactions one species is favourably affected and the other is unfavourably affected. These interactions are always related to exploitation of food. The term predation is applied to the sequence in which one species kills another and then uses it as food. In parasitism all species feeds on the tissues of another without necessarily killing it. Predation is a situation where the "larger" or "stronger" benefits at the expense of smaller or weaker, where as in parasitism, vice versa is the case. The victim of a predator is killed immediately but the victim of a parasite remains alive for extended period of time.

Exploitation occurs between all forms of life, parasitic and predatory interactions could be of different types : (1) animals on animals (the blood fluke, malarial parasite), (2) animals on plants (the herbivore-plant interaction is a specialised form of parasitism) ; (3) animals on microbes (consumption of mushroom by man) ; (4) microbes on microbes (viruses on bacteria, algae and fungi) ; (5) microbes on animals and plants (bacterial and fungal diseases of animals and plants) ; (6) plants on plants (**Loranthus** and **Cusenta** are stem parasites, **Striga** and **santalum** are root

parasites). and (7) plants on animals (insectivorous plants like utricularia and Nepenthes).

Although the dividing line between parasitism and predation is rather nebulous, the extremes in the small internal parasite do show many major differences in addition to size. The parasitic organisms generally possess a higher biotic adaptation than the predators. They are more specialized in structure, host range, metabolism and life history. Such specialisations might be the result of their special environment and the problem of dispersal from one host to another.

Parasitism as a food getting relationship is widely distributed. Parasites cause enormous destruction among wild and domesticated plants and animals. Because of the great human misery and the economic costs resulting from parasitic infection, interactions between the pathogen and the hosts have been extensively studied. Among lower plants parasites are commonly found among bacteria and fungi. Bacteria cause such diseases as rots, necrosis, cankers, blites galls in plants and cholera, diphtheria, tuberculosis, typhoid dysentery etc. in human beings, Smuts, rusts, powdery mildews etc. are common fungal diseases of plants. Some fungi are dermatophytes causing skin diseases. Relatively few higher fungi attack animals. Several fungi are obligate parasites. Some may have specific hosts while others may attack a number of hosts. The host plant usually shows characteristic symptoms of the disease in the form of wilts, necrosis, galls, chlorsis etc. The well known virus diseases of human beings are small pox, measles, polio, mumps, influenza and the common cold. In plants the important symptoms of virus diseases are mosaics, yellowing, stunting and phyllody. Higher plants like **Loranthus** and **Cusenta** are common plant parasites and these cause destruction of wood. In diseases the host is progressively weakened and eventually killed.

Parasites in general show a tendency to become reduced in structure and virus represents the most reduced form of a parasite. Again, in the evolutionary history of parasitism

many patterns are found. There are even parasites of parasites among insects - the so - called hyperparasites - and viruses which infect disease - causing bacteria.

The degree and extent of parasitism vary with individual parasites as well as the hosts. A parasite which is highly pathogenic on one host may be relatively mild on another host. In some cases the host pathogen interaction results in gall formation due to divisions and enlargement of cells. Parasites may be either biotrophic or necrotrophic. In biotrophic or balanced parasitism the host does not suffer much destruction until the parasites reach the reproductive stage. Typical examples are the smuts and rusts. Disease symptoms in these cases are seen only when the parasites start producing spores. The necrotrophic parasites like the wilt fungus, **Fusasium,** on the other hand, kill the host tissues by the secretion of enzymes and toxins.

Parasitic flowering plants may depend on the host plants either partially or completely for nutrition. The partial parasites are green in colour and so do not depend upon the host for their organic food material. They take only water and mineral salts from the host. These may be stem parasites or root parasites. Examples are **Loranthus, viscum, Santalum, Striga** etc. Complete parasites are rare as compared to partial ones. These lack chlorophyll and hence they depend on the host for food. Examples are **cusnta, cassytha, Orohanche** etc.

Most parasites are extremely prolific. The probability of any individual finding a suitable host is very low and therefore, greatly exaggerated reproductive powers are essential for successful parasitism.

The organisms which are intermediate between the predators and parasites (ex. the parasitic insects) often possess the ability to consume the entire prey as do the predators and at the same time exhibit the host specificity and the high biotic adaptation of the parasite. Some of these organisms have been successfully propagated in the laboratory

by man for use in the control of insects pests since chemical control of insects has already been proved to have numerous harmful repercussions. However, attempts to utilise large unspecialized predators have always been unsuccessful. Since the quantitative aspects of predatory or parasitic interaction are greatest when it is of short duration. Artificial introduction of new predators and parasites should be done only after thorough investigation. Similarly, the destruction of predators such as vultures, wolves, foxes and bats should only be undertaken after a consideration of the total population of both predator and prey. An over production of prey can always have a more adverse effect on the ecosystem than the original stable prey-predator relationships. Since man is the greatest predator the world has ever known, he has to be so cautious and prudent in his activities that he does not exterminate his prey by over exploitation. It is very easy for a notorious predator like man and a vigorous grazer like cow or deer to tilt or upset the equilibrium in an ecosystem so much so the exploited species is replaced by other species which are unacceptable for the predator or the grazer. It may be mentioned here that the enormous depletion of the flora and fauna of the Crusadai Islands near Rameswaram has been attributed to the indiscriminate collection of these by biologists on the pretext of scientific study.

Herbivorous Animals

These are plant eaters. Many domestic animals like cattle, sheep and buffaloes belong to the group. In the natural habitats of grasslands and forests the major herbivores are the deer, antelope and bisons. Another large group of plant eaters are the rodents, rats, mice, squirrels and porcupines. Among the insects the grasshoppers, crickets, plant lice and numerous larvae are representative. In the oceans small crustaceans are probably the most important herbivores.

Generally the herbivores reproduce at a rapid rate. The predators eat plenty of them and therefore, sufficient numbers of these must grow to maturity in order to perpetuate their kind. Among the herbivores the rodents

are more prolific than the hooped animals. They cause extensive damage to crops and therefore, farmers at times provide special protection for eagles and owls in order to destroy the rodent pests.

If the predators are eliminated the population of herbivores would increase very rapidly, infact so rapidly that there would not be enough vegetation to feed them. This rapid multiplication of herbivores would lead to complete destruction of the vegetation and this would ultimately result in the death, due to starvation, of most of the herbivores. In nature, under normal conditions, there is a balance between herbivores and the predators and starvation is not known.

Carnivorous Plants

Some flowering plants are capable of trapping small insects, killing and digesting them. Such plants are known as **carnivorous plants** or **insectivorous plants**. They have their leaves modified into ingenious traps. The common insectivorous plants are **utricularia, Biovularia, Pinguicola, Nepenthes, Sarracenia, Drosera, Dionaea and Aldrovanda**.

Utricularia is a submerged aquatic plant which lacks roots. The leaves are much dissected and some of the segments are modified into bladders for trapping and digesting small aquatic animals. The plant is commonly known as bladderwort. Similar bladders are found in **Biovularia.** In **Pinguicola** the leaf margins curve inwards to trap the insect.

Nepenthes produces a pitcher at the end of a coiled tendril. The pitcher and the tendril are only modified parts of the leaf. Small animals are trapped and digested in the pitchers. In **Sarracenia** the whole leaf is modified into a pitcher.

In **Drosera** (commonly called sundew plant) the spoon-shaped leaves have numerous tentacles. Insects are caught by bending the long, marginal tentacles of the leaves over

them. The insects are killed and digested by the secretions from the tentacles.

In **Dionaea** (known as the venus fly-trap) each leaf has a winged peteole and a lobed lamina having numerous spine-like projections at the margins. When an insect alights on the leaf the two lobes move on the mid rip and come together to trap the insect. It is digested and absorbed.

Alduonanda is a common hydrophyte in Bengal. It captures small aquatic animals by a similar mechanism.

Carnivorous Animals

These feed as other animals. Depending upon the animals which are eaten, the carnivores are divided into first-level, second-level and third-level carnivores. The first-level carnivores generally feed on the smallest herbivores. Some herbivores are more numerous than the carnivores that eat them and thus, they feed most of the carnivores. In general, the herbivores are smaller than their predators. However, there are exceptions. The lion, for example, is smaller than the zebra which is killed and eaten by it. These predators may have helpers also. The food left over by lions is eaten by jackals and hyenas. The second-level carnivores feed on the first. For examples, frogs as first-level carnivores eat grasshoppers and worms, and snakes which are second-level carnivores eat the frog. Similarly birds eat beetles and spiders feed on plant lice. The third-order carnivores are those that feed on the second-level carnivores. The hawks or vultures that feed on small birds and the snake that eats other snakes are common examples.

PART II

Environmental Problems Due to Human Activities

Man has caused changes in the environment; that many of those changes may affect the relationship between man and environment; and that population increases and urban concentration contribute directly to pollution and the degradation of our environment. Population growth threatens the world natural resources. Further the industrial revolution, growing human mobility, changing rural landscape, rapid urbanization all are due to human activities. This will have a tremendous impact on environment. However the major problem will be man's anxiety to over utiliee the natural resources. In this section we will discuss the abovesaid problems in detail.

6. Dynamics of Population Growth and Its Impact on Environment

We all know that the population of this planet, the earth, is growing fast. It grows at the rate of about 2 percent per year, and follows a geometric progression, i.e. the additional population also grows simultaneously. At the present rate of growth of 2 percent per annum, the population of the world will get doubled, in about 35 years. Thus, the present world population of about 4,000 millions (1975 estimate) will double to 8,000 millions by 2,010 A.D.

The present rate of population growth is alarming. What is still more alarming is the fact that the rate of population growth itself is growing. Let us take the case of our own country. Our population has increased by 13·3 percent between 1941-51, 21.6 percent between 1951-61 and by 24.8 per cent between 1961-71. What is true of India is true of the two-thirds of the humanity inhabiting the less developed world.

Why is the growth of world population faster now than it used to be earlier? Either the present generation is getting more children than our fore-fathers used to get. The answer may be in the affirmative in case of a few countries, but in the case of most of world nations, the answer is No.

We are all aware that the growth of population is the balance between the people born and the people dead. In other words population growth is the difference or the gap between the birth rate and the death rate. The total population of any area of the earth's surface represents balance between two forces. One is natural changes, caused by the differences

between the number of births and deaths. If births are more numerous than deaths in any period, the total population will increase. If they are less numerous, it will decrease. This simple relationship is distorted by a second force migration. Where migrants are more numerous than emigrants, there will be a population increase. When emigrants are more numerous, there will be a population decline. The fall and rise of birth and death rates are associated with both natural disasters, such as hurricanes and epidemics, and economic fluctuation such as the 1929 depression to the post-war boom of the late 1940s.

Demographic Change

The crude birth rate is defined as the number of births over a unit of time divided by the population. The crude death rate describes the number of deaths per unit of time; crude growth rate describes the difference between the number of births and deaths per unit of time. An increase in population size may mean less food per individual, more births than normal, and a subsequent increase in numbers. Thomas Robert Malthus, the English Demographer saw dire ecological consequences in the continuing growth of the human population. He claimed that population has a tendency to increase geometrically (by increasing amounts as does the series 1, 2, 4, 8, 16......) while the food sources for that population even with improving agricultural methods, increase arithmetically (by a constant amount like the series, 10, 20, 30, 40...), He was able to demonstrate that any rate of population increase (however small) would eventually exceed any conceivable food supply. When growth reached that point, it could be kept in check, according to Malthus, only by 'war, vice and misery'. Yet the basis for the arithmetic growth of agriculture was never made clear. Malthus paid considerable attention in the curtailment of population increase through birth control than to the gloomy devices of war, vice and increasing human misery. In population growth Malthus imagined a fixed point. At this saturation level the population exactly equal the carrying capacity of the local environment (i.e. the number of members of a given species to be the biological capacity

to provide food for). The population growth after reaching the maximum level may have an abrupt fall. It may not reach maximum or may overshoot and create food shortage and show an up and down fluctuation of the carrying capacity.

We can find some rough indications on how environmental checks operate by piecing together historical records of local break downs of food population balances. Famine may be closely related to environmental events. Local human populations respond to changes in the carrying capacity of their environment in different ways. They may store for unproductive seasons, or may migrate from place to place. All the responses to environmental change involve some spatial movements. There may be outward movements (seasonal, periodic or permanent) of population from areas where there is a food deficit or inward movements of food from areas of surplus. These strategies obviously apply only in the case of local famines. Such spatial reshuffling of popuation and resources would not help in the event of a global famine.

Population explosion is one of the greatest problems affecting mankind today. Better medical facilities and control of communicable disease have caused a sudden decline of death rate. Economic progress due to planned activities could not cope up with growing population. Hence, we could not profit from the welfare measures. The only way left to us is the control of members.

·In some developed countries, industrialisation and mechanization have reduced the need for having larger families. But it will take several decades for our country to test this. Hence at the present rate of growth, it may not be possible to aim at the quick social change of the society, a change in the attitudes, behavioural pattern of the people in favour of small family. Due to rapid growth of population and decline in infant mortality rate, nearly half of the total population is below 15 years of age, of which a sizable portion enter into reproductive age group every year.

Rural and Urban

In India the rural population is more as it is an old agricultural country. The villages have cluster of houses which are made of mud walls and bamboo-roofed ones. Sanitation in and around the village is paid very little attention. The wells from which drinking water is drawn are generally shallow, open and not far away from village ponds. These open ponds get polluted during rainy season which leads to a diarrhoea and dysentery. By many community projects these have been overcome. Mostly villages are within the densely populated plains.

There is only about 9.9% of the people that (1971 census) live in towns. This slow growth of urbanization is due mainly to the fact that India's industrial development has been very slow in the past. The towns are centres of administration, commerce, industry and education. Most of the towns in the past developed on account of the strategic position and commercial, religious and administrative functions. With the industrial progress new manufacturing towns are cropping up and the existing ones are enlarging their limits. Lack of civic amenities, poor employment, failure of crops in some years and poor educational facilities in villages are encouraging more and more people to settle in urban centres. Some enterprising people have settled in town to finance factories and establish trade and banking facilities. In short the sizes of the towns are expanding. However, many among the villagers who work as labourers or clerks do not settle in the towns and return to their villages once a year when sick or when they have to attend to some religious or social functions. It may, however, be noted that during the intersensal period 1951-61 urban population increased only by 1.69 crore persons or by 26.2% as compared with the increase of 1.8 crore persons or 41% in urban population during the decennium ending 1951. The rapid increase in the urban population during the period 1941-51 is due, besides other factors, to the influx of refugees from Pakistan.

Towns with a million or more persons are generally found either on the coast or in the alluvial Ganga-Sutlej

plain. Towns in Penninsular India are comparatively small in size. Port towns undoubtedly are the biggest. With the increase in industrial development, some industrial towns such as Calcutta, Bombay, Jamshedpur, Ahmedabad, Kanpur, Rourkela, Bhilai, Nagpur and Madras have established colonies of housing workers. Inland towns are mostly situated on the river banks or near their confluence. These are mostly fort towns or sacred places with bathing ghats. In the plateau region and at Rajasthan either old fort towns or walled court towns with palaces and temples or mosques. They are generally situated on steep-sided hills. Wherever modern planned urban areas are built near old towns, striking contrasts are visible. Wide metalled streets with open grassy plots, western style buildings with ornamental flower beds and newly planned towns contrast with the crowded narrow lanes of old towns. Near industrial towns many slums have come into existence which house in some cases as many as 25% of the total population of the towns. Slums have increased in the recent past owing to the influx of the rural population in search of employment and slow pace of the building of dwellings as compared to the rapid establishment of factories in big cities which were already crowded. Increasing population has built suburbs near old fort towns. These low lands sprawl on the flat level places at the foot of the hills over which forts are located. Some of our fort towns such as Bombay, Calculta and Madras are easily comparable as regards their imposing buildings, social life, modern amenities and size with big European and American towns.

The alarming rise in the population in greater Bombay and the rapid industrialisation of certain pockets in Maharashtra to the detriment of other regions are agitating the minds of authorities as well as economists. The National Committee on Science and Technology has given an outline of what the country's scenario would be in 2000 A. D. Any reasonable conjecture would lead to the conclusion that the 21st century would be a technological society, in the sense that the major conditioning factors of human life, both individual and social would be machines and techniques

developed on the basis of scientific knowledge. In this period of fast social changes, the study of the future becomes our indispensable instrument for analysis of problems.

With the limited scope for development of agriculture in the State and the consequent emphasis on industrialisation, urbanization would be on the increase and it would be the bane of development. According to the report of the TATA Economic Consultancy Services, the population would reach 87.8 million by 2001. By that year, only about 44% of the couples would be protected and a birth rate of only 28/1000 will be achieved, as compared to 29/1000 now.

The urban and rural composition of the population in 2000 will depend upon several factors including the level and spread of economic development. The percentage of world urban population to the total rose from 26 in 1951 to 31 in 1971. It is expected to increase from 38% to 40%° in 2000. Comparable figures for our country as a whole were 16% in 1851 and 20% in 1971. Concern is expressed that the development, particularly in the industrial sphere, is slanted towards urbanisation at the cost of the rural sector.

This industrial development has given rise to a lot of villagers migrating to towns. To prevent this, government has taken out the industries to less advanced areas by offering them attractive inducements. Even this is not fully successful. For example at Konkan, though it has resources such as water supply and other facilities to start an industry, but still no one is coming forward to start the industry. Here the government should take interest and do the needful. Another example of urbanisation and its further development with increased population, services and other factors, is that they have created a lot of environmental problems.

According to the 1971 census, in terms of number of urban centres, Tamil Nadu stood first with 443 towns as against 289 in Maharashtra. 75% of the total urban population of 12.5 millions is concentrated in the bigger towns

which number 123, while the rest is distributed in the remaining 320 smaller urban centres. The five urban agglomerations of Coimbatore, Madurai, Tiruchi, Salem and Madras account for nearly 43% of the State's urban population, Thanjavur being predominantly agricultural area, the social life has not changed perceptibly.

The basic service considered essential for a satisfactory urban environment are water supply, drainage and transport apart from medical care, education and other social requirements. These are inadequate in the large urban centres of Tamil Nadu and some of the services are conspicuous by their absence in the smaller ones. It is officially estimated that the total urban population served with protected water supply is less than 10 millions, distributed over 100 urban centres. The sewage system exists only in Madras and Madurai, five municipalities and four townships and a few town Panchayats covering, just about 3.75 million population. Transport poses a major problem.

Many towns like Thanjavur, Trichy and South Arcot as given by Town and Country Planning Act, are unsatisfactory. The sanitation and hygiene are woefully inadequate in all these districts. Trichy Taluk with 71.27% of its population living in towns and cities, is the most urbanised among the taluks of the State. It continues to be the biggest town group in Tamil Nadu. In most towns like Madurai, the Madras Town Planning Act, 1920 on the basis of which construction and development activities were sought to be regulated, remained more as "pious hopes".

Urban concentrations and agglomerations arise due to 'pull' impulses generated by secondary and the tertiary growth, aided by 'push' factors like under and unemployment in the rural areas, The town is still considered as the answer for a man's aspirations to economic and social advancements. Many villages in South Arcot and interior areas in Thanjavur district are deserted owing to migration of population from these pockets to urban centres in search of jobs or for better life. As a result, the rural

areas are deprived of persons who could modernise agriculture and improve village life also. In the urban areas, the influx adds to unemployment and growth of slums is accentuated.

The land utilization pattern in most of the southern districts presents a picture of hazards and unco-ordinated development. Lands under parks, play-grounds and other open spaces in many towns are very meagre, resulting in a congested unhealthy environment. The major extent of land is under residential use. Lands under communication and industry occupy the most place followed by parks and play fields. Commercial use accounts for the smallest extent.

The towns planned several hundreds of years ago in Tamil Nadu appeared to have had a self-contained existence for a long time until British rule brought in amenities like railways and other modern means of transport and communication. That accounts for the expansion of areas, though, it has not been commensurate with the population growth. The problem may become complex now.

Long-run urban development strategy should develop thinking, planning and actions that would help to create a healthy atmosphere for town life. The development of new towns which will help drastic redistribution of population absorbs surplus rural labour in industries which in turn will develop new growth centres as well as achieve closer employment - residence linkage.

The dense population in villages has to depend only on the agricultural activities as there are not much ancillary industry present in the villages. This leads to unemployment problems in the villages. Most of the family members call themselves agriculturists but do not engage themselves in the productive activity. Such people are actually a burden to the limited production of the village. If there is any new industry started near the village, the chance for employment makes them move to the adjoining industrial region, thus creating population increase in these places. Daily movement is again a problem; hence the transport will have to be

developed. This in turn will create problem by traffic routes, which may have to be laid on the productive lands. The increase in the population of the nearby urban centres leads to varieties of problems. In villages, where the agricultural occupation is the only employment opportunity; the people being mostly uneducated do not control population growth per family; hence the problem of too many people living in rural areas creates local problems.

Those who come to cities do not like to go back to the rural areas; they first create an increase in the urban population. The other problems will automatically follow such as employment to newly migrated population, development of house in all the productive lands being acquired for transport, education, medical and other recreational facilities. These changes first bring about a physical environmental problems. Next problem is the pollution. The waste, dumped by constructions, the smoke from automobiles and factories, sewage water, drainage problems, availability of quantity of water for daily use, all these are the environmental problems created by the development of urban centres. These urban centres further develop and become metropolitan areas. In the process of enlargement they also pull the adjoining villages under their influence, which in course of time creates social and cultural problems. For example we can take Calcutta. The city has enlarged to megalopolis of teeming millions. This has shortages of all kinds like water for house use, roads, power, buses, trams, cabs, hospitals, schools, colleges, parks, playgrounds, market places, public conveniences which have made life a struggle for existence. The house of a family is as small as a room, a thousand vehicles crowd through narrow streets and the air in Calcutta is laden with more carbon monoxide than in almost any other city. These environmental problems have been created by the urban population which goes on enlarging its facilities and services. A place develops slowly by providing facilities for the local population. These facilities give rise to more population increase locally and by immigrants. The quick exhaustion of the local resources leads to further problems.

Age and Occupational Structure

The following table will show the distribution of population by age as per 1971 census in India.

Table—6.1

Age Group (years)	Population (Million)			Percentage distribution		
	Male	Female	Total	Male	Female	Total
0—14	118.9	111.4	230.3	41.9	42.2	42.0
15—19	25.2	22.2	47.4	8.9	8.4	8.7
20—24	21.6	21.6	43.1	7.6	8.1	7.9
25—29	20.3	20.5	40.8	7.2	7.8	7.5
30—39	35.5	33.5	69.1	12.5	12.7	12.6
40—49	27.5	23.6	51.2	9.7	8.9	9.3
50—59	18.0	15.4	33.4	6.3	5.8	6.1
60 and above	16.9	15.8	32.7	5.9	6.0	6.0

Source : Statistical outline of India, 1978.

The above table shows that the population below 15 is the maximum. Again the age level between 30 - 39 is more. The mortality above 60 is quite high which is clear from the table. The total population is as high as the other age groups. There is a clear difference between the first age group and the sceond age group.

The population at age level between 0-14 is the highest. Mostly the children from the slums and the rural areas do not go to schools. They have been detained at home to help the elders in minding their younger brothers and sisters. Thus the children are brought up as useless citizens for the future. The age level between 15-19 are nearly 47.4 million who are in

the age level of demanding jobs. If they are not provided jobs the unemployed people will be adding to the local problems. Even the population with an age limit between 30-39 years are, the energetic population. These people have to be properly utilized.

Occupational Structure

Classification of population and workers by educational levels 1971 are as follows :

Table—6.2

Educational Levels	Urban		Rural	
	Total	Of which workers ('000s)	Total	Of which workers ('000s)
Illiterate	52,141	11,295	335,263	103,415
Literate	56,462	20,545	101,630	44,089
Total	108,603	31,840	436,893	147,504

From the above table it is clear that in the urban centres illiterates and literates are almost 50% each but the workers from literate are more than from the illiterate. In the rural areas the illiterate are more as they are mostly engaged in the productive work, for example agriculture and so on and the literates are compartively low.

The following table will show the economic classification of the workers:

Table—6.3

	1961	1971
Agricultural workers		
Cultivators	99.6	78.2
Agriculture labourers	31.5	47.5

Manufacturing, Processing, etc.

	1961	1971
Household industry	12.0	6.4
Other industry	13.2	10.7
Construction	2.1	2.2
Trade and commerce	7.7	10.0
Transport and communication	3.0	4.4
Others ; Including Forestry and fisheries mining, etc.	19.6	21.0

The working population in rural and urban areas, as the 1971 census shows as follows :

Total rural population-438.9 million out of which 225.2 million are males and 213.6 million are females. The total urban population is 109.1 million out of which 58.7 million are male and 50.4 million are females. Out of these the workers population in the rural area is 148.4 million. Among this the male population is 120.4 million and female population is 28.0 million. The working population in the urban areas is 32.0 million out of which 28.7 million is male and 3.3 million female.

Population Epidemiology

Environmental resistance is a curb imposed on the biotic potential of a population, when some factors of the environment reduce the notality rate, or increase the mortality rate, or both. The two density-dependent on factors of starvation and disease, which regulated population levels till lately, have now been overcome by technology.

Pollution of the environment occurs as a consequence of over-population, through deposition of unwanted or toxic products on land, air and water and threatens the break down of natural systems and human health, and offends our aesthetic senses. Pollutants consist of man's body-wastes, garbage (paper, cloth, plastics, metal cans, organic

and inorganic by-products), pesticides, pathogenic organisms, industrial wastes, noise and smoke from chimneys, automobiles, and air-craft, all of them lead to health hazards of the highest magnitude. Obviously enough the environment, once viewed as infinite, can no longer assimilate these wastes. In the industrial regions the industrial wastes are thrown in the surrounding places and this pollutes the place. The emission from the industries pollutes the atmosphere which may lead to a lot of lung diseases. Thus in many places the industrial wastes have led to asthma, T. B., cancer and skin diseases. Hence the population growth has given rise to the demand for more and more economic facilities; this has given rise to industries and other activities. The more the population the more the demand, the health hazard will become inevitable. Hence the growth has to be checked to provide the needs of the people.

Population Planning and Control

The accent to day must be on the small family norms and responsibility of parents in restricting their families. The motivations for limiting family size should be the economic welfare of the family and educational opportunity for the children. The death by many causes are controlled by specialists from various fields. But it is expressed by an educationist that every individual could be responsible for controlling death. Similarly, to make the people realize the hazards of a large family, less food and improper place to live, it is essential to educate each citizen of the country. Proper planning is to make each person realise the need for population control. Personal comitmment to arrest population growth is therefore a basic need. Any amount of technological development is not enough, if man is not made to be aware of the danger by over population.

The various methods used to initiate a feeling towards the need for control should include information such as the importance of healthy living and the importance of nutrition. This in turn will make them limit their families for the betterment of their own-health and social status and

for providing better opportunities and living conditions for their children.

The family planning programme has been suggested as one of the measures to control population growth. Our country even after so much of technical developments, has people who believe in the old faiths and traditions. Hence various methods for family planning have not proved to be a complete success. People have still not started realising fully that the increasing number of members in each family lies within the control of each individual. Some people due to certain supersitious beliefs refuse to follow them. In some places the advocacy of these methods has been misused to such an extent that people have started opposing this. Hence the present concept is to achieve population control by stressing the welfare of the family. The educated people have themselves realized the danger of over population and have followed various methods to control the family size. The others have been easily convinced and changed to control measures. But the population in the rural areas is alarming. They are mostly uneducated; hence it is very difficult to make them realise the value of a small family. It is also a delicate factor to explain to uneducated mass to the complete participation of the people in controlling the population. It will be a difficult one; this may be possible in the long run, but immediate result is doubtful.

A new official study group formed by the Family Planning Forum consisting of economists, demographers, journalists, sociologists, and medical scientists has suggested that the minimum needs, integrated rural development, adult literacy and other welfare measures should be linked along with the family planning instruction, so that the achievement will be complete. These should also make the people voluntarily accept small family size.

It has been suggested that the evolution of an operational strategy to achieve the target of reducing birth to 20 per 1000 in 1982 - '83, may be tried. This has taken into consideration the child and maternal health services,

mobilisation of voluntary effort in a larger measure, revival of choice of method to control the members per family.

On the whole voluntary efforts and qualitative improvement in the life of the general masses to achieve population goals is much needed. All plans and controls should make each one realise the hazards of large family size and over population of every country.

7. Utilization of Natural Resources

The gifts of nature in the form of 'Natural Resources' and their consequent development by man go hand in hand. Ecology tells us that the biosphere is unitary, that the natural life-support systems of species on the earth are highly interlinked. Approximately three hundred thousand species of green plants and micro-organisms are recognized as primary producers and these are consumed by more than a million other species of organisms. Environmental scientists all over the world are concerned over man's abuse of the resources in the name of human progress. By making use of the natural resources man tries to satisfy his wants and this material progress is achieved. Land is cultivated, forests are cleared ; rivers are harnessed for irrigation, power generation, navigation, recreation, etc., minerals are exploited ; industries are developed ; roads and railways are constructed and multi-storied buildings are built. All these represent the whole paraphernalia of modern civilization, that is born simply out of man's effort for satisfying his wants.

Natural resources play a significant role in the nation's economy. They are the foundations of the material prosperity of the nation, both present and future. Their wise use therefore is the concern not only of all the people but also at all levels of government. From the beginning of civilization, every nation's basic wealth and progress has stemmed form its natural resources. Our entire society rests upon our land, water, forests and our minerals. How we use these resources influences our health, security, economy, and well-being.

The natural resources exert a vital influence on social welfare and progress.

> The significance of natural resources for social welfare flows in major part, from the belief that they are scarce and further more exhaustible, and that imprudent resources management endangers the welfare of the future generations.

It is this fact that is our present concern. There are two basic versions of a doctrine called 'increasing natural resource scarcity'. One rests on the fact that the stock of natural resources is absolutely lmited. Once this limit is reached, continuing population growth would require increasing consumption of resources. This in turn would bring about diminishing returns to be operative in future years. The other version views diminishing returns as a current phenomenon. Thus it reflects decline in the quality of resources as successive parcels are brought within the margin of profitable consumption.

Limitations of Resources

It is true that resources are limited. But the population multiplies continuously. In the absence of restriction on the use of resources, population increases to the limits of the capacity of the resources to sustain population. The incompatability of a finite stop of resources with the provision of sustenance to a continually increasing population entails an eventual decline in benefits per capita, and stoppage of growth. This is the economic scarcity effect.

It is also interesting to note the extent of man's exploitation of resources is staggering, particularly in the most recent period. We know that the world population doubled between 1800 and 1930. It is doubled again between 1930 and 1975. Further it is likely to increase. Thus there is a demand for a massive consumption of available natural resources. It is estimated that by 2000 AD the world will need a tripling of aggregate food output, a five-fold in iron alloys, and a tripling of lumber output.

How long will the reserves of the earth's non-renewable resource last? It is very difficult to answer this question. This

is mainly because more than the resource depletion, the resource undergoes a persistent decline in quality. The decline in quality may be due to two factors:

(a) over exploitation

(b) increase in the per capita consumption of resources. Both these factors are due to the increase in population. Thus it is clear that the consumption of resources is a function as the rate of population increases. Further consumption by an individual has also increased. Let us take the case of energy consumption. The biological minimum for primitive man was about 100 thermal watts per capita. As other sources of energy, notably firewood were added, the level rose to around 1000 T. W. per capita. Then continuous mining of coal and porduction of oil brought an exponential increase of around 1000 T. W. per capita. Now, under the rates of consumption of the present decade natural resources that too hundred million years to form by sedimentation will have been consumed in about hundred years of industrialization. This example shows that though the quality and quantity of a resource can be increased but ultimately the population growth will have tremendous impact on the utilization of a resource.

Problems in the Utilization of Resources

In the process of utilization of resources, several problems crop up. The indiscrete exploitation of natural resources leads to many unhappy consequences. For instance the damage to natural vegetation, water, wild life and recreational resources has already been large and widespread, especially in developing countries.

Sometimes dredging the seabed for minerals or drilling for oil are not without after effect. This not only adversely affects the environment but also the fauna in that area, particularly the benthic fauna because of the sudden reduction of dissolved oxygen. Another effect is due to the addition of nutrients or heavy metals that are added during these operations. Next let us see the problems due to misutilization of resources. For example let us

explain the problems of coal mining industry in India. In India, reserves of coking coal are limited. It is indicated that the prime coking coal may get exhausted in about 40 years time. This prime coking coal is essential for metallurgical purposes. Today our steel industries are badly in need of coking coal. The production and consumption of coking coal (vide Table) in India is likely to give a clear picture in this direction.

Table—7.1

Production and Consumption of Coking Coal

Year	Production	Consumption by Steel Plants	Coking Coal Used for Other Purposes
1956	14.03	3.40	10.62
1957	15.32	3.65	11.66
1958	15.40	4.18	11.21
1959	14.80	5.91	8.88
1960	15.28	7.74	7.54
1961	17.04	9.08	7.95
1962	13.36	9.87	7.51
1963	17.50	10.83	6.67
1964	16.72	10.28	6.43
1965-66	16.96	11.50	5.46
1966-67	16.58	11.85	4.72
1967-68	16.11	11.25	4.86

It is very clear from the table that in a period of 10 years due to our negligence, 93.51 million tonnes of coking coal have been utilized jor non-metallurgical purposes. It is a tragedy that a huge amount of valuable resources is wasted and ultimately the development of iron and steel industry will be hampered. It is a well known fact that coking coal cannot be replaced. This will clearly indicate the problem involved in the misutilization of coking coal.

Similarly there are several other problems in the utilization of resources.

Irrational Utilization of Forest Resources

Forest resources form an important (integral) part of the programme for optimum use of land. Forests have two major functions, protective and productive. Productive function includes supply of raw materials for industries such as construction, furniture, rayon, plywood, matches, resin etc. The demand for forest products both as industrial raw materials and domestic fuel has been increasing. It has been estimated that the removal of wood from the forests of the world is 14,000 million cubic metres annually. Of this 54% of the wood comprises of industrial wood and 46% fuel wood.

On the protective side forests help to get good rainfall, check soil erosion, flooding and silting of rivers. Reforestation is required in areas dwelled by strip mining. This has been the case in the coal mining regions of the Appalachians in U. S. Here forests reduced erosion, minimised arid drainage and helped wild life. Areas having flash floods can be saved by means of afforestation.

Once we realise the importance of forest wealth, it is easy to understand the impact of national use of forests for human welfare. We know the Himalayas have a natural cover of vegetation ranging from subtropical to subarctic. The wealth of flora both in terms of variety and produce is indeed great. In the recent years due to several causes, damage to natural vegetation, particularly to forest in the Himalayas has been extensive. The fellings have been excessive. It is observed that in the Himalayan Bias basin due to excessive agricultural activity there enormous encroachment is seen on forest area. There has been extension of terraced cultivation in the forest and incidence of heavy grazing. Thus the indirect effects of deforestation are micro-climatic changes, landslips causing loss to life, property and communications, erosion, lowering of water table, etc. All these ultimately created hardships for the people lowering the agricultural productivity.

Another possible effect of irrational use is the extinction or depletion of particular species of trees. For instance if no attempt is made to replace seedlings of teak in order to maintain a balance, then there will be a death of teak wood.

Largescale destruction of forests leads to severe soil erosion, heavy flooding and silting of rivers. This has become an increasing phenomeno in almost all parts of India. We have enough evidence to show the after effects of deforestations, in the Nilgiris, Western Ghats and in Himalayas. In the Nilgiris the state legislation never allows destruction of virgin forests. It has been observed that in recent years one comes across destruction of large patches of virgin forests in remote areas in Gudalore and Coonoor taluks. The agricultural department of Tamilnadu felt that such destruction has resulted in the soil erosion, flash floods, landslides in the Coonoor taluk in December 1978. Sometimes deforestation also results in the occurrence of drought hazards. Parts of Dharmapuri District in Tamilnadu can be cited as example for the above said phenomenon. Largescale migration of elephants are noticed especially at the foothills of the Dhinhans forests near Sathyamangalam in Tamilnadu. Here the forests were cleared for the purpose of domestic fuel.

Conservation of Natural Resources

In recent years, the concern about environmental ecology the depletion of natural resources, the rapid growth of population (population explosion) and the consequent shortage of food has been mounting. Scientists are concerned about the chances of survival of human race.

Conservation means wise and efficient use of world's natural resources so that it produces greater possible benefits to man over the longest possible period of time. Conservation promotes proper use of the natural resources to ensure a continuous supply of resources for future generations.

Soil Conservation

This is done by reducing run off and making the soil absorb more moisture and nutrients. This can be done by

growing deep rooted crops and deep ploughing. All these minimise run off and increase absorption of water of the soil. The soil fertility can be improved by the use of organic matter, manuring and ploughing. Terracing and contour bunding will reduce runoff and sheet erosion.

Conservation of Water Resources

When forests are cut and vegetation destroyed the land will not hold moisture. In dry season water drops, rivers dry up, lakes shrink. During the rainy season water flows off fast due to the barren ground surface (slopes) giving rise to floods in the two lands. This alternate shortage during the dry season and excess during the wet season is to some extent solved by the construction of dams. These dams check floods and retain water for irrigation and for other purposes. The growth of forests and vegetation on the upper slopes is another important means for maintaining water supply. With the rapid growth of population and industries its demand for water is increasing.

Conservation of Forest Resources

In India we have an acute shortage of fuel and wood and so nearly 400 million tons of cow dung is needed as fuel instead of using it on land as manure. Destruction of forests damages all natural resources. Hence deforestation should be checked. Creation of a few wild life sanctuaries is essential for the conservation of both forests and animal life as the animals can go about in their natural surroundings.

Modern methods of conservation are the recycling of wastes eg., The Guindy Engineering College Environmental Science Department is conducting experiments in recycling of sewage water. Sewage water of the whole college is collected in tanks, cleaned of oxidation and used as fertiliser in the coconut grove located in the premises.

Conservation programmes should be had for forests, wild life, soils and minerals.

8. New Biotic Communities and Ecological Imbalances

Community is an assemblage of population living in a habitat. It is an organized unit within an ecosystem and functions as a unit. Biotic communities could be broadly classified into two broad categories. They are the major communities and minor communities. The major community is fairly independent of inputs and outputs from the adjacent communities. It has its own size and completeness of organization. On the otherhand, the minor communities are dependent on the aggregations in the neighbourhood. The communities have their characteristic trophic structures and patterns of energy flow. In general, community is changing its appearance, structure and function in time. It is quite amazing that diverse groups of organisms thus live together in an orderly fashion.

One important feature of the ecosystem is the variety of ways in which it maintains itself in a balanced state. The cycling of minerals from organisms to environment and back is one example. The means of controlling the population size to a particular level is yet another example. Cataclysmic changes like natural fire, flood, avalanche, or man-made changes on landscape by building or creating a new lake behind a dam, abandoning of an unproductive land, etc. make the original ecosystem get destroyed. A new ecosystem is created in that place. Besides, biotic community changes follow ecological changes. A sequence of biotic stages of new ecosystem develops from what was initially a barren land. This is a kind of ecological succession.

For example, building a dam brings about effective increase in arable acreage. Large bodies of water create temperature gradient in overlying layer, resulting in high wind velo-

cities. Seepage of water from dam, reverses the ground water flow. High hydrostatic pressure of dam changes the ground water to desert side. Marine fisheries get impoverished as fresh nutrients are not available to fertilise the sea. Sometimes even diseases spread due to water logging, as it is breeding ground for mosquitoes and other vectors of disease causing germs. In Egypt, the building of Aswan Dam witnessed the increase in Schistosomiasis, Malaria etc. because of the swampy dam. The root cause of all this tragedy is man trying to "improve" on nature before he understands the ecological implications of his actions.

Let us consider another example namely a pond environment. In a pond environment, change in biomass will lead to increase in dead organic matter, changes in nutrient content and physical shape. This may increase the species diversity. Each species may provide for a new group of animals. Changes in plant species will lead to changes in animal species. New species may be added. Some of the old species may disappear because of changes in habitat. Thus, man's attitude and endeavour definitely has an impact on ecosystem.

Challeuge to Diversity

Species diversity is the characteristic feature of all living things. Diversity is high in biologically controlled ecosystem more than the physically controlled ones. Diversity is an expression of the possibility of constituting the feed-back system. Higher the diversity means, the longer the food chain and more the symbiotic relationship. It may mean greater possibility of negative feed-back controls. Diversity is more in older communities than the new ones. Predation affects the diversity of prey. This helps the less competitive species with a better chance to use space and resources. Man as a predator tends to reduce the diversity and encourage monoculturcs.

In any complex ecosystem, species diversity is greater and hence the ability to withstand stress is also greater. Here diversity means stability. In a simple ecosystem, the number of interactions between the species is often insufficient

to maintain stability, as the species number is few and the number of habitat for animals is also limited. For example in an extremely cold climate or dry desert climate, the species variety is few compared to the tropics. In all ecosystems, a high degree of correlation exists between the diversity and stability.

Species diversity decreases as a result of many human activities. Monocrop agriculture is one such example. Agriculture has favoured raising a single species of plants in a place where there is multiplicity of species in a natural condition. Monocultural manipulation of the environment has adverse effects, besides minimising the diversity of life around him. Creating a new biotic community provides a challenge to the diversity of nature. It promotes instability in ecosystem by rupturing the feeble food webs. Besides it initiates changes in population interactions.

Instability in Ecosystem Regulation

Self maintenance and regulation is not only a characteristic of an individual, but also that of a population in an ecosystem. Regulatory mechanisms do operate for the good of the ecosystem as a whole, although at times, it may be for the detriment of certain individuals. Prehistoric man probably lived in perfect harmony with the environment. The trouble really began when man started manipulating the environment to make things easier for him. The dawn of agriculture is a giant step forward in this direction. To cultivate plants, water is needed. When the rainfall is not sufficient, streams and rivers have to be diverted to irrigate the land. Thus the sub-ecosystem changed. Building dams and watersheds create additional problems of preventing the silt movement and reducing the fertility of the delta and sea. This reduction in the flow of minerals, started changes in natural ecosystem. Besides it threatened the human settlements with the vulnerability to earthquakes.

As water diversion causes desertification in other areas , forest clearing or destruction for agriculture results in erosion of soil and permanent loss to all vegetation. Similarly,

when grazing is severe, wild grasses are replaced by shrubs unpalatable to cattle. Overuse of pesticides has killed the predators rather than the pests. By the advent of urbanization, farm-lands gave place to freeways, buildings and gas-stations, all with concrete material. The application of herbicides has destroyed the forests. Atmospheric pollution also has threatened the trees all over; pesticides get associated with plants, and animals and eventually man the biosphere.

Changes in Population Interaction (Competition, cohabitation and Coexistence) **Survival and Extinction**

All organisms in an ecosystem are in competition for the same basic requirement, namely the source of energy. What kinds of competition do we observe in an ecosystem. They are the intraspecific and interspecific competitions. In an interspecific competition, the two different species living in the same general area have similar ecological requirements. The more the overlap between the niches' occupied by the two species, the greater the degree of competition. The frequent result of such a competition is the decline and sometimes eventual extinction of the least adapted species. This is what we call the competitive exclusion principle or the Gauses's hypothesis.

The two species with similar ecological requirements cannot successfully live together for any length of time. Dr. Thomas Park of Chicago University once did elegant experiments on Flour beetle species, **Tribolium castaenum and T. confusum**. He proved that hot wet condition is the favoured climate for the former and cold dry for the latter. If the cultures were belonging to any one of the above conditions, then only one species survives in the competition. But if the cultures are kept in alternate weather conditions of hot wet and cold day, there is no extinction. Competition appears to be extremely important in determining the distribution of closely related species. Competitive interactions can cause morphological changes that can enhance ecological separation. Evolutionary development favours coexistence and diversity.

Habitat diversification can reduce competition so as to allow coexistence instead of exclusion. When a simple 'one

niche' environment is changed to 'two niches' environment, competition is reduced sufficiently for the support of two species.

The other competition is intraspecific one which means within its own population or community or species. When the populations of two species interact, it can do so in many ways. The ways of interaction could be termed as positive, negative or neutral. In a neutral situation, neither population is affected by the interactions. In positive interactions, mutualism and cooperation is established when both the parties are benefited. If one is benefited and the other does not lose anything it is commensalism. If one is affected and the other is not gaining it is amensalism, If one gains at the expense of other, it is parasitism and predation. If both the parties lose, it is competition and mutual inhabitation. The competitive interaction often involves space, food or nutrients, light, waste materials, susceptibility to carnivores, disease and so forth. Interspecific competition can result in equilibrium adjustments by two species or it can result in one species population replacing another, or forcing it to occupy another space or to use another food. In some cases, members of one population may eat other species, compete for food, excrete harmful wastes and thus interfere with other populations.

For a given species pair, the type of interactions may change under different conditions or during successive stages in life histories. That means, the two species may exhibit parasitism at one time, commensalism at another and completely neutral at yet another situation. In the evolution and developmeint of ecosystem, negative interactions tend to be minimized in favour of positive symbiosis that enhances the survival of the interacting species.

Pesticide Contamination

To protect his food crops, man has killed several insects using powerful insecticides. These insecticides pollute the rivers and seas and land all over the world. The pesticide pollution has affected biological productivity and poisoned all

the species. It took several years for man to know the evil effects of DDT like substances until Racheal Carson wrote epiclimatology book "The silent spring" which shook the people all over the globe. Maximizing the agricultural yield without regard to ecological principles has produced its backlashes or the biological "boomerang".

Pesticides belong to few categories, some biodegradable, in the sense that they could be metabolized or modified in time. Some are nondegradables like the DDT, and other chlorinated hydrocarbons. There is no evolved natural treatment process for them. They accumulate and get magnified in our systems. For example, DDT spray in the field could reach our system through plants, fishes, poultry, meat and milk products. Besides these pesticides could combine with other compounds in the environment to produce additional toxins, pesticide pollution is aggravated by the aerial spraying of our landscape. Pesticides get absorbed on organic matter to be transported in air droplets and get concentrated during the food transfers from plants to animals and man. Another set of contaminants are the weed killers. Herbicides like 2-4D (Di-chlorophenoxyacetic acid) were considered handy for cotton picking if the leaves are removed before hand, by spraying the plants (with 2-4D). In some countries herbicides were used to clear the vegetation for laying the powerlines, railroads and forest defolition (in Vietnam War) as well as weed control. It is now quite clear that the insecticider, weedincides and other pesticides or the bicocides are the powerful drugs of the ecosystem that modifies the vital systems of producers and consumers. As the levels of pesticides have risen up in the environment that will quickly be transferred to living and human systems with potential carcinogenic and other consequences, pollution or monitering has become a real need. There is an enlightened move in some quarters of the world that the use of pesticides has to be registered through governmental agencies, so that the production, distribution, use and testing conld be regulated, and licenced on a par with narcotics, dangerous drugs etc. As the physician who is qualified to handle the dangerous drugs is empowered to adminster at times of

human need, competent environmentalists should be empowered to regulate the usage of pesticides at times of need.

Biological Control Measures and Their Impact

Biological control is a method of pest control ; it relies on natural enemies like parasites, predators, pathogens to reduce the pest populations to a tolerable level. The advantage of biological contol is that it is a natural phenomenon. The procedures of biological control involve identification of a natural pest, its evaluation, recovery of the natural enemy, its import including quarantine reception to avoid the import of viral and bacterial contamination. Mass-culture of these insectivorous species, field colonization, establishment of a spread, post-colonization-evaluation and repeat performances lead to desirable effects. The advantage of this system is that it does not have the backlashes of pesticide contamination. But this is a slow, time consuming and labour intensive process.

One distinct disadvantage of this system is occasionally the predator population increases so much that it becomes a pest for something else which needs in turn to be controlled. To control the Cottony cushion scale insect in California Lady beetles were introduced which in turn needed to be controlled. Otherwise, the story of biological control is a success in the control of rhinoceros beetle, coconut moth etc. Pest management is a holistic framework and it needs an integrated approach to the problem involving host plant resistance, plant sanitation, crop-rotation, suppression of soil erosion, increasing plant diversity in ecosystem, careful timing of planting and harvest, clean cultural practices including tillage etc.

Ecological Imbalance

The interdependence of organisms results in what is known as the balance or equilibrium of the ecosystem. It is a very delicate balance in numbers of the constituent population. An understanding of the factors that control this balance is essential for studying population. It is generally found that favourable conditions like sufficient water supply and nutrient availability always lead to abundant plant growth. The

increased supply of plant food induces a higher rate of reproduction in the herbivores. This greater availability of food results in multiplication of the numbers of successive groups of carnivores. In a similar fashion unfavourable seasons for plant growth would lead to decrease in the numbers of herbivores and hence in the multiplication rate of carnivores. Thus population sizes of the various components of ecosystem fluctuate considerably due to the imbalances in same components at particular levels. Factors that affect any single functional components of an ecosystem afiect all the other either directly or indirectly. Starvation and death are uncommon and will occur only under extreme depletion of food supply. In natural ecosystem species which is considered to be natural enemy holds the other in check.

Food Chains and Food Webs

Green plants utilize the energy from sunlight to synthesise carbohydrates from the water absorbed from soil and the carbondioxide of the atmosphere by the process of photosynthesis. In nature it is this fixed energy that is utilised by all other living organisms for growth. The energy trapped by the green plants is transferred to the herbivores and then to the various carnivores and to a host of scavangers. This transfer of food energy of the plants through series of organisms with repetition and being eaten is referred to as the food chain. Every time when the food is transferred to about 80% of the stored energy is lost as heat. Therefore the number of such transfers has to be limited, usually to four or five and greater amount of energy is available in organisms which are nearer to the beginning of the chain (or in shorter food chains). There are two important types of food chains; i) The grazing food chain which starts from the green plants and going to the grazing herbivores and then to the carnivores, and (2) Detritus food chain which originate from decaying organic matter and into saprophytic microorganisms then into detritivores and finally to their predators.

All the different food chains occurring in an ecosystem are often interconnected. This system is commonly

referred to as the food web. Organisms which obtain food from the primary producers (namely the plants) same number of steps are considered to belong to the same tropic level. In complex communities the green plants from the first tropic level, the herbivores occupy the third level and the secondary carnivores like the lion that feed on the primary carnivores form the fourth level. It is also possible that organisms of the third and fourth tropic levels can occupy a shorter food chain by eating only the plants. Quite often such organisms like dog, fox etc. exhibit a somewhat intermediate trophic position by consuming both plant and animal food.

The concept of trophic level is not primarily intended for classifying organisms. It indicates the stepwise flow of the potential energy stored in the plants through the different components of the community. It is likely that any particular population may be involved in more than one trophic level.

Initially only a small fraction of the available sunlight energy is fixed by green plants. As mentioned earlier, certain amount of stored energy is lost as heat at each food transfer*. Therefore, the number of consumers who could be supported by given source depends very much on the length of the food chain. Fish ponds and oceans are good examples to show how the length of food chains, primary, productivity and interference by man could influence secondary productivity.

In some cases the length of the food chains influences the accumulation of large qualities of certain substances in the later links of the chain. This phenomenon is known as biological magnification or food chain concentration. Among the numerous reports the accumulation of radioactive wastes and DDT food along chains are the best known.

Quantitative estimates have been made for food chains. In general, the relationship between the different links are similar

*Thus, the available energy decreases with each link in the food chain.

to a pyramid. Large numbers of smaller organisms are always found associated with a few large organisms. Similarly the total weight of the organisms decreases with each successive level just as does energy storage.

An important aspect of food chains is the productivity which is the rate of energy storage. Primary productivity is the rate of storage by the producer organisms (both photosynthetic and chemo synthetic organisms). Secondary productivity is the rate of storage at the consumer tropic levels and is dependent upon primary productivity.

Homeostasis

A comparison of living matter with inorganic materials clearly indicates that the living things show a definite selectivity towards the environment and that this preferential selection is a characteristic of all living matter. A critical study of the aquatic environment of the earth, like streams, lakes, seas and oceans as well as the different environment of the crust, clearly indicates the occurrence of partially selected environments to which organisms respond selectively. There is also the possibility that different organisms might show different sensitivity to different environment conditions

Living organisms characteristically maintain intricate balance with changing environmental conditions. When the organisms become incapable of maintaining this balance death occurs. The dynamic balance achieved by the organisms is mainly through self adjudgement. Homeostasis is the term which refers to this balance as well as to the self-regulation mechanisms by which this balance is maintained. In the broader sense it is possible to consider homeostasis and biology as synonymous.

Entrophication

One of the greatest threats to life on earth is the ever increasing loss of diversity of habitats and. vegetation. As more and more land forms are levelled for cultivation, these and neighbouring lands get eroded. Similarly forests are destroyed for selfish gains and basis of soil fertility and the

habitats of wild plants and animals disappear with them. However, the surrounding drainage systems might get enriched with organic and inorganic nutrients. The rapid accumulation of such nutrients commonly known as entrophication will be destructive to the natural ecosystem. It may be mentioned here that in most such cases the nitrates are more easily leached out of the soil surface and concentrations in stream effluents often exceed the health levels recommended for drinking water. Again with loss of special habitats many plant and animal species become restricted in their range or even become extinct. Similarly in land forms the widespread and often excessive application of fertilizers for agricultural operations has given rise to environmental damage by its acceleration of entrophication of many inland lakes and rivers.

The damage caused by certain chemicals can be controlled or removed by suitable measures. Unfortunately in the case of fertilizers, worldwide changes towards refined agricultural practices contribute only in increasing the conditions which are likely to make the situation worse. Greater efforts should therefore be made to ensure the more discrete use of agricultural chemicals.

Limiting Factors

The basic requirements of different organisms vary with species and with the environmental conditions under the balanced conditions of the ecosystem. The essential materials-available minimum-required will tend to be the limiting one. However this law of limiting factor is less applicable under this condition where the amounts and the effects of many constituents are rapidly changing.

Liebig (1840) was the first to demonstrate that yield of drops was limited not by the nutrients required in larger quantities but by the same raw materials needed in minute quantities. His statement that "growth of a plant dependent on the amount of food stuff which is presented to it as minimum quantity" is now known as Liebig's law of the

minimum. It is now known that this law of the minimum is just one aspect of the concept of limiting factors which in turn is but one aspect of the environmental control of organisms.

Some Examples of Ecological Imbalance

The principle of balance of species of ecosystem breaks down in places where a given organism has never lived before. The introduced species often gets out of control. One example is the weed parthenium. This was introduced in India from Mexico in the 1950's through wheat shipments. There were no natural enemies and therefore, in the favourable climate it soon got out of bounds and began spreading all over south and central India.

Another item that causes imbalance is deforestation especially from steep slopes. When the trees are removed rain drops hit the soil surface harder and this results in greater leaching of humus and the surface soil. Soil erosion occurs and the microbial activity in soil is affected and ultimately the composition of the soil itself changes. Similarly forest fires also cause imbalance. After the fire, the material left in the burnt over area retard recovery. The charred materials protected by the charcoal covering undergo decacy only slowly. In the worst case even the humus is burnt out of the forest soil. Such areas remain barren for many years before protective forests grow up again. Besides this, the destruction of the wild life of the area will also be considerable.

Sometimes pests upset the balance species, for some unknown reasons. The repoductive rate to the pest some times becomes abnormally high. This results in considerable destruction of vegetation.

Overgrazing again causes imbalance. In natural habitats this is often due to an over population of herbivores. The worst cases of overgrazing can even lead ultimately to starvation and death of many of the herbivores. Many years may pass before such a region gets back to the original level. Overgrazing may also result from maintaining numerous domestic herbivores in an area for too long a period.

The destruction of grass lands by ploughing for farming is another case of imbalance, If there is not enough rainfall or irrigation, rehabilitation will be very slow.

These examples indicate that any disturbance in the natural balance among species may prove disastrous. Thus there is need for studying the situation very carefully before undertaking any ruthless destruction of vegetation. Man is also capable of improving life in the neutral areas around him. Trained scientists who have experience with natural habitats know what to do.

9. Changing Rural Environment, Urbanization and Industrialisation

Changing Rural Environment

The rapid growth of population has had its impact on both the rural environment as well as the urban one. The impact has been much more pronounced in the villages than in the towns. This is so mainly because of the fact that life in the rural areas is very close to nature. In fact, much of rural life is dependent on nature.

The population of our villages has doubled in the last 40 years or so. The additional people need food, clothing, shelter and other facilities. To produce more food, people have extended cultivation of crops over larger area. In the process, much marginal land, which normally should not be cultivated, has been brought under cultivation. Such land includes steep slopes, pastures for cattle grazing, wooded areas, groves and gardens, and areas liable to flood and soil erosion. The increase in population and need for more food has created a sort of land hunger in the rural areas. As a result of this land hunger, forests have been felled and pasture lands cleared for cultivation. Now we have much less shade in the rural areas to protect us from the scorching sun than what our forefathers had. And that too when the people to use the shade have increased so much. Not only shade, we need now much more wood for fuel, furniture, agricultural implements, buildings and a variety of other uses. So we need more forests now than a generation earlier. Unfortunately, the area under forests has depleted fast in the last few years.

Similar is the fate of pasture areas. As the number of people grows, the demand for animal products increases. To get better yield from the animal wealth, we have to feed them well. So there is a greater demand for fodder and pasture lands now. But pasture areas too have continuously shrunk in size in the last few decades.

The indiscriminate expansion of agricultural area and continued encroachment on forest and pasture lands has resulted in serious problems. Not only we have lessened supply of forest products and smaller pasture areas for grazing, we also face shortage of land for houses, schools, playgrounds etc. The additional population in the village is being accommodated in the same space which was available a generation earlier. Thus there is overcrowding in the villages. A large population is being huddled in a small place. Open spaces in the villages have disappeared and the sanitary conditions have worsened. The social and psychological influences of such overcrowding are also serious.

Indiscriminate extension of cultivation to steep slopes and destruction of vegetative life has serious repercussion on the environment. The leaves of trees and grasses are decomposed and go back to the soil to enrich the humus content. This helps to improve the soil structure. The plant life protects the soil from the impact of the hard hitting rain drops. The roots of trees and grasses bind together the soil and prevent soil erosion. They also check the speed of the run-off. This allows rain water to be on the slope for longer time, which in turn, results in greater percolation and recharge of the ground water storage. Greater ground water recharge means larger amount of water for wells and tubewells for drinking water supply, irrigation and industrial purposes. Larger underground storage also results in greater seepage in the river valley, making the river flow more perennial. Destruction of vegetative cover has a telling effect on all these aspects.

The removal of vegetative cover due to clearing of forests and pastures has left the slopes exposed to speedy run-off and

the hazard of soil erosion. Soil erosion deprives the land of the fertile upper layer which is washed away to the river valleys and tanks. Silting of river valleys and tanks has resulted in many problems. Silting of the valley results in reduced capacity of the river to carry rain water, and coupled with unchecked speedy run-off from the slopes, results in floods. The devastating floods that have ravaged North India in 1978 are fresh in our memory.

Similarly, silting of tanks and reservoirs has now reduced their capacity to store water. Thus irrigation potential is reduced. Silting also leads to spread of water over larger surface area, which in turn, results in greater loss through evaporation. In olden days farmers used to shift the fertile silt from the tank bed to the fields when the tank bed went dry. Now this laborious practice is waning perhaps because of changed socio-economic and cultural circumstances.

Apart from extending cultivation over larger area to produce more food, people have also intensified the use of crop land. Earlier they usually produced only one crop from a field. Now they get two or three crops from the same field. Continuous production of crops has resulted in decreased fertility level; people used to keep the land fallow for a season or so to enable it to recoup the fertility loss through the natural process. They also used to apply green manures and compost to increase the fertility. All these methods improved the soil structure and the soil fertility by providing decomposed organic matter to the soil. These practices are now disappearing from the rural scene due to various reasons. Instead, farmers now use greater amount of chemical and inorganic fertilizers. These inorganic fertilizers boost up the fertility of the field, but do not help to maintain or improve the soil structure.

Along with greater use of inorganic fertilizers, there is increasing use of chemicals for plant protection purposes. Chemicals are now sprayed for killing insects, pests and undesired weeds. Such large-scale use of chemicals has its adverse effects on the micro-organisms which help to

decompose the plant and animal life and restore it to the soil.

Another important change in the rural scene is the development of transport and communications, and the opening up of the rural areas which are now more accessible. Contact and interaction of people with the outside world have now changed the attitudes and perception of the people. The natural hazards were used to be tolerated earlier as expression of the wrath of God. Now it is viewed as a calamity which needs to be fought at different fronts. Similarly, the expectation of the people for better living conditions, health, hygiene, housing and sanitation have been aroused. There is increasing awareness of the environmental problems in the rural areas today.

Industrialisation and Urbanisation

It is a known fact that the population of the world has been steadily increasing. Throughout the world, population is getting more and more concentrated in the cities and large towns. Many urban centres have experienced rapid growth in the 20th century. The proliferation of cities and towns is a result of industrialization. But there is a slight difference in the causes for urbanisation between America and Europe on one hand and India on the other. In the west, urbanisation was a result of industrialisation that is decrease for labour in industries located near urban centres. In India on the other hand it is due to lack of demand for labour in the rural areas and the consequent migration from rural to urban areas. Secondly in the west a large majority lives in urban centres, while in India the reverse is true. In India urbanisation has produced huge aggregate of urban population. But this urban population forms only a small proportion of the total population.

The following table gives the proportion of urban and rural population in some countries of the world in 1975.

Table-9.1

Urban and Rural Population

Country	Percentage to Total Population	
	Urban	Rural
West :		
U. S. A.	74	26
Canada	76	24
B. Germany	75	25
W. Germany	75	25
England and Wales	77	23
East :		
India	20	80
China	15	85
Pakistan	25	75
Indonesia	18	82
Bangladesh	8	92
Thailand	13	87

The table clearly shows that countries like India, China, Pakistan, Bangladesh, Thailand and Indonesia have a large proportion of people living in the villages as well.

Urban population in India has increased from 25.8 million that is 10.9% of the total population in 1901 to 109.1 millions that is 19.9% of the total population of 1971. The major cause for this rapid increase in the number of urban dwellers is rapid industrialisation which has attracted the rural population towards the urban centres.

Job opportunities in agriculture do not increase with increase in population. The only places where employment has

increased rapidly are in the concentration of industries near cities and towns.

Many large cities like Delhi, Bombay, Calcutta, Madras, Madurai, Coimbatore, Trichy, Tirunelveli, etc. have numerous industries located near them. Industries are also located near larger towns. Most of these cities and towns have expeienced rapid growth in population in recent years. For example Madras had a population of 397, 552 in 187I. It increased to 509, 346 by 1901; 777, 481 by 1941 and by 1951 the population had risen to 1 million-it was 1.4 million. According to the 1971 census the population of Madras City is 2.47 million.

In recent times it has been noted that people move from the city centre to the city boundary along the major transportation lines that diverge from the city. The causes for this urban sprawl are deteriorating environmental conditions in the city coupled with location of industries outside the city. This urban sprawl is an irregular haphazard settlement which takes place along the transportation lines in the suburbs scattering residences; urban sprawl has also resulted in the changes in the economic and racial composition of the city population. In general, the urban expansion as a result of rapid urbanization, has created numerous urban environmental problems. In the following lines let us take some of these probelms to discuss with suitable examples.

(a) Crowding

Crowding is a conspicuous ecological force impinging upon modern man. It results from more than a simple increase in population density. It is the product of physiological needs and social contacts. Crowding can be defined as excessive number of persons per unit space relative to the activity of the individuals, their form of culture and quality of their environment. The growth of urban traffic and the increased numbers of all sects of society have all contributed to the feeling of crowding. Crowded human population is often characterised by poverty, malnutrition, lack of facilities such as housing, educational, medical, recreational, etc. and various environmental hazards and

unstable social patterns. High population densities increase mortality among the very young, neglect of young by mothers and increase in aggression and conflict. High population density is the cause for increased mortality among the very young, neglect of young by mothers and increase in aggression and conflict. High population density is the cause for increased crime, drug abuse, mental illness and stress in urban areas. Crimes are more prevalent in large cities. The rate of violent crime in big cities is more than five times than in smaller cities.

(b) Housing

In India there are 548 million people and 97 million families (1971), but only 93 million housing units. So there is a shortage of 4 million houses. Shortage of housing is also felt in most of the large cities and towns in India. For example in 1971 there were 338, 414 occupied residential houses and 444, 788 households in Madras city; about 26.0% of these are classified as 'Katcha' if their walls and roofs are considered. Many of these households located in the crowded parts of Madras city such as George Town, Triplicane, Mylapore, etc. do not have the basic amenities such as bathroom and lavatory. Many households share the same kitchen. These houses are ill ventilated and tenented by a number of families who share meagre toilet and water facilities.

(c) Slums

Rapid urbanisation has given rise to several problems in the cities and towns and slum is one of them. Cities like Bombay, Calcutta. Delhi and Madras have slums ranging from 500 to 1500. The number of persons living in slums account for 10 to 60%. of the city's population. That means a large proportion of people in these cities live in depressing conditions of poverty, misery and overcrowding. These produce unhygienic conditions and many problems for existence. These slums are located on margins of roads, canals, unutilised public and private land. They consist of

small huts with thatched roof built without consideration of roads or access ways. They do not have facilities for drinking water or toilet. Cattle, pigs and goats which the slum dwellers rear compete with humans for space in the slum. The animals contribute to the already filthy surroundings. The slums present a major urban problem in most of our cities. For example Madras city has 1202 slums in which 737,531 people or 163, 804 familles live. 42% of the total slum dwellers are migrants. Most of the migrants have come from other districts within the State. It is interesting to note that more than a third of the slum dwellers in the city have migrated from Chingleput district itself.

Slum population accounts for 33.5% of the city's population. 58% of the total slum dwellers of Madras city are illitrate and only 27% of the total slum population are workers. So 73% of the slum population are unemployed and therefore pose a serious problem in upsetting the ecological balance of the city.

(d) Urban Climate

As large cities grow in size, so does their impact on the environment. The overall climate of a city reflects the origin where the city is located. But large cities can modify some of the climatological factors in their immediate vicinity, resulting in a relatively small scale but important variation in climate, which is called a microclimate.

With increase in growth and three dimensional complexity, the mean temperature in the city tends to rise, focussing what has been called **an urban heat island**. This results from the loss of evaporative cooling normally provided by vegetation and exposed soil, the gain of reradiated heat from pavement and building surfaces, and heat produced directly by factories and buildings. The most striking temperature differences between the city and the country, are seen. in the daily high and low .temperatures

which tend to be attenuated in cities are 0.5 to 1°C warmer than the cities near rural areas. The result is the formation of urban heat island or thermal mountains over cities.

Particulate matter provides nuclei for the condensation of atmospheric moisture into precipitation drops or rainfall. The city's effects on rainfall are difficult to quantify, but there are some data which suggest that as cities grow in size the rainfall on the city proper increases. Cities may also produce an orographic effect, resulting in rainfall. Because of the rough surfaces they present to the wind, cities tend to experience reduced wind velocity.

Regardless of its velocity, the air of cities is especially rich in fly ash, dust and particulate matter of all sorts. These materials have a climatological effect as well as an aesthetic and public health impact. Particulate matter can reduce the natural radiation received by a city by 15%,

(e) Pollution

The introduction and movement of particles into the air by combustion processes - burning gas. oil gasoline and wastes (industrial and domestic), creates what is known as a 'dust dome' over cities The large particles remain suspended over the city during day over a long period. Continuous introduction of particles create a dome shaped layer of haze. The dust dome is a basic factor in the more serious aspects of air pollution. Calcutta is very much polluted by slicon dust around it. This dust causes rain to be acidic. Air pollution in cities often leads to respiratory diseases. Dumping of wastes is another form of surface pollution, which one comes across in cities. Certain low lying areas in Royapuram and Nungambakkam in Madras city are raised by these wastes. This makes it difficult for the inhabitants to live there. Apart from this, overflow of drainage pipes adds to the surface pollution in the old parts of cities and George Town in Madras is a good example where one finds the man holes and sewage pipe adds to the surface pollution In addition to air and surface pollution noise is another form of pollution in cities.

Urbanisation leads to spatial problems such as urban sprawl, segregation, incompatible land uses, decay. pollution, traffic congestion dumping of wastes, etc. Economic and social factors are important in affecting the problems of our cities. Cities are places where people live together. The rise of crime and segregation problems in our cities seems to be related to social aspects of city life. This occurs when there is increased urban growth and different sets of people place authority for existence. The dangers of walking along in portions of our cities at night becomes more and more apparent. The psychological effects of urban living lead to a desire for adventure and delinquent behaviour. Crimes such as theft, alcoholism and house breaking are usually committed by the unemployed. The incidence of crimes is said to be high among the slum dwellers.

Planning Urban Areas—Urban Renewal

Generally the degree of deterioration of our cities is so great that major redevelopment collectively known as urban renewal is necessary. Any different degrees of renewal may take place from reconditioning a small area in the oldest part of the city to rehabilitation and redevelopment. Renewal measures are also applicable to other regional problems within the city eg. transportation and related commercial uses, housing, sewage, protected water supply, drainage, etc. For example the drinking water supply distribution system in Madras city was expanded from time to time to meet the increasing demand, without proper planning. This gave rise to problems of unequal supply and drop in pressure and quantity of water supplied to most of the areas. To rectify this defect the redesigning of the the city's water supply system was taken up. Apart from this most of the trunk mains and feeder pipes supplying water were very old and they were replaced for effective distribution.

Urban Water Supply

Water is one the essential needs ot the city both for industrial and domestic purposes. Hence it is necessary to estimate the amount of water needed with increasing

population and spread of industries for example the population of Madras city has increased from 509, 346 in 1901, to 2.47 million in 1971. With this increase in population the amount of water consumed in the city has also increased from 85 million litres per day in 1931-1932 to 168 million litres per day by 1958-1959 and 205 million litres per day by 1971.

The main source of water to the city is the Kortalyaar river. The anicut across the river diverted the water to Cholovaram and Red Hills lake and water is diverted from this. With the increase in demand for water, due to increase in population, the sources supplying the city at present are considered inadequate, Therefore alternate sources of water have to be found. The entire ground water resources in and around the city have been estimated and they will not be enough to meet the growing needs of the population in the city.

The entire city will require protected water supply and with growing demand, more water will have to be purified. Further the distribution system in the city designed in 1914 has become inadequate. All these have resulted in the putting up of numerous pumps to tap the underground water. The low pressure in the distribution system is liable to pollution, thus creating health hazards. Therefore in the light of all these it is necessary to keep the water supply system modernised from time to time to meet the needs of the population with the vertical and horizontal growth of the city. It is also necessary to plan for future requirements considering the population 20 or 30 years ahead, at the present rate of growth. These require very careful planning and execution.

Urban sewage forms another important urban amenity, for the disposal of domestic and industrial wastes. Efficient sewage systems exist only in certain parts of the city. In places like Santhome and Mount Road the coming up of multistoried buildings has added to the load on the sewage pipes. Most of the sewage pipes in the oldest parts of the city such as in George Town are too narrow to dispose the existing wastes; with the result in most ot the places the sewage water overflows the man holes and creates permanent cess pools.

They add to environmental pollution which affects the health of the people living in these areas.. The sewage pipes have to be extended to the newly developed residential suburbs of the city and the existing outmoded lines will have to be replaced by new pipe lines. Therefore constant renewal and planning are important from time to time to meet the heavy load on the sewage pipes with the vertical and horizontal devlopment ot the city.

The above cited example of Madras city clearly indicates the growing urban environmental problems, which need careful attention in the process of planning. Urban transportation is another major problem in the field of urban environmental planning. Finally one is able to see in the modern world both rural and urban landscape is threatened with environmental problems.

PART III

New Emerging Environmental Problems

In the modern world the growth of the economy has been marked not just by greater production but also by an accelerating pace of technological innovation. This innovation, although it has provided new solutions to environmental problems, has also created a vast range of new problems. New chemicals, new uses for metals, new means of transportation, novel consumer goods, new medical techniques, and new industrial processes all represent potential hazards to man and his surroundings. The pace of technological innovation has exceeded our scientific and regulatory ability to control its injurious side effects. The environmental problems of the future will increasingly spring from the wonders of 20th century technology. In the future, technology assessment must be used to understand the direct and secondary impacts of technological innovation.

In view of these facts let us discuss these emerging environmental problems in detail.

10. Pollution

We can define 'Pollution' as the introduction of harmful substances into the environment. These substances are the results of direct or indirect activities of man. In undisturbed ecosystems, dead organisms and excreta quickly decompose and their nutrients are recycled for reuse. On the contrary when contaminants are added to ecosystems beyond what can be readily absorbed through normal cycling of nutrients then it becomes pollution. Pollution affects the atmosphere, hydrosphere and lithosphere. Consequently there is a general alteration and deterioration of the basic components of the abiotic environment. Since biotic environment is interrelated with abiotic one, the different organisms are greatly endangered. The pollution brings unanticipated disturbances between producers and consumers. nutrients and organisms and as a whole a deterioration to the quality of the environment.

A pollutant is any form of energy or matter causing pollution. It may be a single element such as lead or mercury or a simple compound such as carbon-monoxide, nitrogen oxides, or DDT or it may be a very complicated matter like sewage water. Noise, radiation and heat are also considered to be pollutants. Each pollutant is able to bring a variety of disturbances. They act individually or in combination with other pollutants resulting in many different forms of harmful effects.

The pollutants, pollution effects on human society can be categorised as :

(1) **Direct Effects**

(i) The quality of the surroundings will deteriorate; there will be congestion, litter, crowding. scarcity and thus the quality of life is degraded.

(ii) Health deterioration will be prevalent; Lung and blood diseases and cancer will increase.

(2) Indirect Effects

(i) Interference to the natural ecosystems and man-made ecosystems resulting in food shortage; For example, pollution brings destruction of vegetation, extinction of fish and other animals and poisoning of waters etc. The agricultural lands which are man-made ecosystems are also affected by chemical pollution.

(ii) Inducing unexpected hazards : For example disposal of solid waste by land filling may result in destruction in ground water cycle. More factories may bring 'acid rains'; continuous destruction of soil and natural vegetation may result in desertification.

(iii) Man's own creation may be destroyed : For example air pollution brings correlation to constructed buildings, sculptures, etc.

The abovesaid facts clearly indicate the significance of pollutants in the deteriorating quality of environment. These pollutants can be classified into two broad groups :

(1) Biodegradable Pollutants

These are normally organic compounds. Vegetative wastes, sewage water and excreta of animals etc belong to their group. In the long run these kinds of pollutants are absorbed by the ecosystem and completely dissolved. Now the character of the original matter or substance will not remain stable.

(2) Nondegradable Pollutants

These are all the various synthetic chemicals. They are compounds, such as Detergent, DDT, Chlordane and dieldrin. These chemicals are absorbed but not dissolved and their original character will remain which is considered to be very poisonous (toxic). Whcn these chemicals pass from one organism to another through the food chain,

accumulation of these chemicals will result in. For example the grazers which graze in DDT sprayed field get an increase of DDT content in their blood and bones. The increasing DDT content can cause harmful effects to its subsequent generations. Thus 'poor quality' organisms result in subsequent generations.

Pollution Areas

We have already explained the fact that pollution involves danger to abiotic and biotic environments. In this process it will introduce quality deterioration to different areas of the components of our environment. The primary areas of environment which are affected by pollution include air, water and soils. Now let us see each area of pollution in detail.

Air Pollution

We know very well that clean, dry air is the combination of nitrogen (78%) oxygen (21%), orgon (0.93%) carbon-di-oxide (0.03%) and other elements which are in lesser proportion. But this combination is largely disturbed by various industrial and urban activities. Various kinds of industries emit large amounts of smoke, disposes chemically contaminated water and dusts. The automobiles and thermal power generating plants burn enormous amounts of fossil fuels. As a consequence of this, they let out smoke and various other chemical compounds. When these pollutants enter into the air they disturb the balance of the gases and affect the circulation of the atmospheric system at different levels.

For many people who live in industrial and urban societies, the air pollution has already become lethal. The respiratory ailments and cancer casualities frequently occur. Air pollution has increased the diurnal range of temperature. Inversion of temperature becomes very common. Smoke, fog and smog days are on the increase. In Western Europe, it is found out that acidity of rain water in the past 10 or 12 years has increased tremendously (frequently pH levels of 3 or 4).

The five most important air pollutants in industrial countries are carbondioxide, sulphur oxides, hydrocarbons, nitrogen oxides and particles of liquids, solids, dusts and ash. The following table presents the types of sources and pollutants in most of the industrial cities of the western countries.

Table –10.1

Estimated Amounts of Air Pollution

Millions of tonnes/year

Source	Pollutants				
	Carbon monoxide	Sulphur oxides	Nitrogen oxides	Hydro-carbon	Parti-cles
Transportation	64.0	1.00	8.0	16.6	1.2
Industries and heating	11.5	32.00	10.0	5.5	16.0
Waste disposal	8.0	0.1	0.6	1.6	1.1
Fires: Forests, coal wastes, agri-cultural wastes	17.0	0.6	1.7	8.4	10.0
Total	100.5	33.7	20.3	32.1	28.3

It appears from the table that carbon monoxide dominates the scene.

This carbon monoxide is able to absorb oxygen from the blood; therefore it reduces oxygen supply to the blood cells, causing the heart to work hard and lungs to breathe heavily Nitrogen oxides also have the same qualities. Sulphur dioxide causes asthma, bronchitis and allergic disorders. Hydrocarbons are involved in rising cancer deaths. The particles and asbestos are associated with lung cancer, asthma and bronchitis.

India's main problem of air pollution arises from the fact that most of our industries are concentrated in highly congested and highly populated cities. Air pollution problems of our selected major cities, estimated by National Environmental Engineering Research Institute (NEERI, Nagpur) are presented in the following table.

Table—10.2

Air Pollution in Major Cities of India

City	Pollutants	
	Sulphur dioxide microgram/ Cu.m.	Particles microgram/Cu.mg.
Ahmedabad	10.66	306.6
Bombay	47.11	240.8
Calcutta	32.88	340.7
New Delhi	41.43	601.1
Kanpur	15.97	543.5
Madras	8.38	100.9

From the table we come to know that Bombay, Calcutta and New Delhi are the most affected cities. When we visit Chamber of Bombay we come to know that the oil refineries, fertilizer plants and industrial plants make this area a big "gas chamber". Whenever one crosses Basin Bridge and Ennore Stations of Madras city, one cannot miss the huge chimney of the thermal belching out dark thick smokes with a lot of dust. It is estimated that every year we seem to add about one million tonnes of carbon monoxide, three million tonnes of sulphur dioxide, nearly one million tonnes of hydrocarbons, five million tonnes of particles and 0.2 million tonnes of hydrogen sulphide by burning fuels alone to our environment.

Apart from health hazards, air pollution is able to cause damages to crops, metals, stone carvings and buildings and climatic conditions. The following table presents some of the air pollutions and their sources (10-3).

Table—10.3
Pollutions and Sources

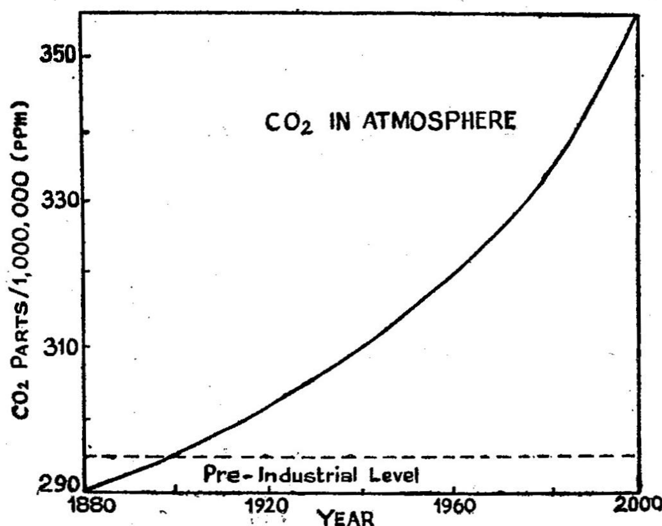
Source of pollution	Major pollutants	Possible damage
Automobile exhausts	Carbon monoxides	Reduction of oxygen from blood cells.
	Nitrogen oxides smoke	Dust penetration to lungs
Petroleum Refining	Hydrogen fluorides smoke	Irritation and corrosion.
Chemical industries (including fertilizer plants	Ammonias	Inflamation of respiratory system
	Hydrogen fluorides	Irritation and corrosion
	Hydrogen sulphides	Bad smell-rotten egg. Vomiting sensation Irritation to throat and eyes.
Metal processing	Arsines	Breakdown of red cells Kidney damage Jaundice Damage to chlorophyl
Cement industries	Dust smoke	Irritation Heavy breathing Damage to crops Poor visilbility
Paper Textiles bleaching	Chlorines	Pulmonary edema irritation, damage to skin and respiratory tract.
Furnaces; metal plati-ng Fumigation	Hydrogen Cyanides	Interfere with nerve cells, headahe, vislon damage.
Various sources of industries automobiles	Particles of dust, Liquid and ash	Poor visibility Headache Irritation Temperature inversion

When these various pollutants involve chemical reactions in the atmospheric gases and result in oxides of sulphur and nitrogen and ozone, then they are called photochemical reactions. The photochemical products are much more dangerous pollutants. Oxides of sulphur, nitrogen and carbon are able to produce weak sulphuric, carbonic and nitric acids, when rain occurs in the air pollution areas. Throughout Europe many famous buildings, monuments, and art treasures are endangered because of the erosional effects of acid rains.

There has also been injury to agricultural crops. For example, ethylene, a toxic substance, results to the reaction of ozone (from atmosphere) and hydrocarbons. A very small concentration of ethylene is able to influence falling of flowers, dropping of leaves and retard the growth of vegetables such as tomatoes and greens.

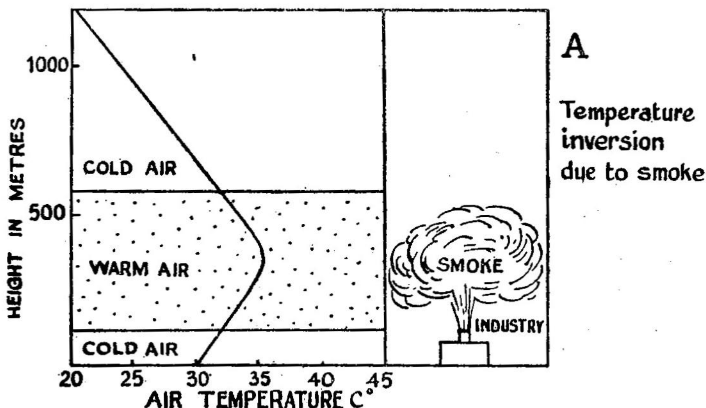
Air Pollution and Climatic Effects

Air pollution is able to affect climate in global as well as local scales. Co_2 content of the atmosphere is steadily increasing because of air pollution. It has been estimated that the Co_2 content has increased about 10% from the pre-indus-



trial level. By about 2000 AD it may reach to 25% increase (Fig. 10.1). This is having a far reaching effect on the global climatic conditions. The major aspect would be raising of the average level of sensible heat in the atmosphere. Warmer regions become hot climatic regions; enormous amounts of snow melting will cause global floods and submergence of populated coastal areas.

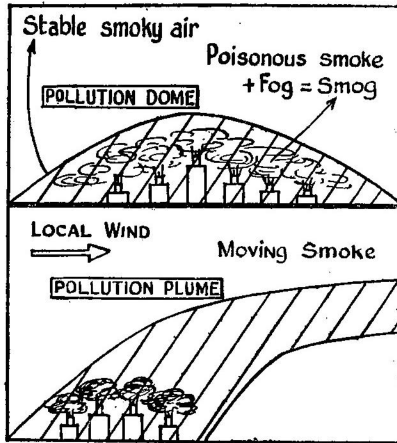
We can now turn to the local effects of polluted air. Fig. 10.2 portrays schematically the pollution problems in local climates. We know very well that temperature decreases when we go to higher elevations at normal conditions. But when dust particles and smoke occupies the lower regions of the atmosphere, then comparatively a warm air stratum occurs at 300 to 400 metres altitude. This causes temperature inversion in the industrial or urban areas (Fig. 10.2-A). Breathing becomes heavier and visibility becomes poor. When this aspect stays as canopy over the urban regions, fog with smoke occurs and this is known as smog (Fig. 10.2-B). This creates a domal air column in the urban region called pollution dome. When local wind is stronger enough to spread the smog along its path then a pollution plume develops. It spreads to nearby agricultural region. This polluted air column is able to cause damages to trees, buildings, water and human beings.



B

CANOPY OF POISONOUS SMOKE BRINGING FOG CALLED SMOG

POLLUTION DOMES AND POLLUTION PLUMES



Water Pollution

Although water covers nearly 75% of the earth's surface, only about 0.8% of the water on earth is available for human consumption. Man's activities require a great amount of good water. In industries, agriculture, community health and domestic purposes water is a must. Apart from this the saline water in the seas and oceans is related with fish and marine wealth. Thus pollution to water is not only a simple environmental quality deterioration but a seriors economic, social and public health problem as well.

Water pollution can refer to any type of aquatic contamination as given below ;

(1) Adding of sewage and other oxygen-demanding wastes which will enrich the water with nutrients-mostly organic.

(2) Adding particulates either suspended ones or unsuspended solids - mostly inorganic.

(3) Enriching with radioactive substances.

(4) Adding toxic chemical substances which will eliminate part or all of living organism.

(5) Allowing organic chemical wastes into the water.

(6) Adding heat by means of chemical or heated industrial waste water.

(7) Colour addition-which will involve failing photosynthesis of aquatic plants.

(8) Oil contamination.

Sewage wastes let into streams, rivers and lakes pose many kinds of problems. These waters contain pathogenic bacteria which cause health problems. Water-borne diseases like typhoid, bacillary dysentery, amoebiosis, jaundice etc. are associated with sewage contaminated water. These wastes reduce the oxygen content of the water. Large amounts of various aquatic-lives perish in course of time. Further, they may lead to extensive growth of aquatic weeds which impair navigation, fish production and other types of economic activities.

Soil and mineral particles are yet another kind of serious water pollutants. Particulates reduce the incoming of the sunlight energy; therefore the aquatic plants and fauna register stunned growth. When particulate water is arrested in dams as reservoirs, silting will endanger the life of the dam. If the particulates originate from mining areas, acidity of the water will get increased. It is able to corrode dams, bridges and valuable soil structures. This water is dangerous for domestic and agricultural consumption.

Radio active materials such as radium, strontium and uranium are highly poisonous. The water draining the uranium concentration mines of water disposal from industrial, medical and research plants which were radioactive elements, is highly contaminated with toxic material. This has cumulative effects on human beings.

Industrial activity such as pulp and paper productiou, tanneries, brewries, sugar mills, textile bleaching and food processing generate waste water that may be discharged into rivers and streams. Some of these wastes are organic in origin and others are inorganic in nature. Organic compounds are

degraded but very slowly: this produces unpleasent odour. The chlorine used in chemical bleaching also results in bad smell·

Lead poisoning to a certain extent, is associated with water pollution. For example arsenic, a toxic material is present in many of the pesticides. When rain water contains large amounts of this pollutant and is collected in a pond which is used for drinking purposes then the problem is much more serious. This is a commom problem in our villages, especially Chengleput, Ramanathapuram and Tirunelveli districts where still most of the village people depend on untreated pond water for drinking purposes. Lead, as a cumulative poison, is able to cause death.

Mercury is yet another compound, when improperly used is able to cause serious environmental problems. Mercury is present in many of the industrial products. Mercury containing compounds find use in laboratories, hospitals, power plants, etc. It has been reported in Minamata Bay on the south-west coast of Kyushu in Japan, the mercury poisons produced crippling and total effects. Due to the accumulation of mercury poisons, the central nerve system of the people had been affected who ate fish and crab from the adjoining coasts. The damage to human beings included, deafness, blurring vision, numbness to limbs, lips, and tongue, cellular degenation and death. This disease is named as Minamata disease.

Today more than 12,000 toxic industrial chemicals are in use. The production and use of these chemicals involve about 60% of available fresh water. Thus one can imagine the magnitude of water pollution. In India Ganga waters from Delhi to down stream, Cauvery in the Erode-Salem stretch, the Periyar in Kerala region, Sabarmathi, Narmada, Tapti of Baroda-Ahmedabad region and Damodar valley stretch-Suraj regions are major regions having water pollutions. For example in Durgapur-Asansol region, it is estimated that 160,000 cubic metre of waste water with 43,000 kg biochemical oxygen demanding substances is produced per day from eight of the major industries. The treatment of this disposal re-

quires about 16 million rupees. This disposal is equivalent of a sewage disposal of a town of 200,000 size (about the size of Tiruchirapalli town).

Water used to cool industrial units and apparatus is heated. This water when released to the natural environment is able to cause Thermal Pollution. Electrical power generating plants, atomic units, metal casting units, coal and petroleum complexes and food processing units generate this kind of pollution. The higher temperature is able to cause changes in the physical and chemical properties of water. Solubility of salts gets increased; oxygen content is reduced; and evaporation gets increased. Because of this water salinity is increased and having negative effects on agriculture. Reduction of oxygen results in death of acquatic plants and fish.

Perhaps the most serious pollutant is oil. Many pollution incidents occur due to spilling and leakage of oil from tankers afloat on the sea. Leaking of the offshore wells also causes oil pollution. It is estimated that about 1280 million litres of oil are spilled every year into the ocean. This is able to pollute about 14,000 km. of coastal area having about 6 metres width. If one year's oil spill of the world is allowed to float Indian coasts, then our entire coast is completely destroyed. Along the shore biological effects will be more extensive. Oil can cause massive kills of fish, aquatic birds and animals.

Soil Pollution

Soil pollution and water pollution are highly interrelated. By drainage systems and hydrological cycle pollutants in the water are able to cause pollution to the soil orl and Apart from the sewage and chemicl compounds solid wastes and different kinds of weed and insecticides pollute the soil. These pollutants also influence the water pollution.

Solid wastes are produced by municipal, industrial, commercial and agricultural activities. In the western countries it is estimated that 4.5 kg. of solid waste per day per person is generated. The estimate is without the inclusion of

abandoned automobiles. Many of the solid wastes are odorous and unsightly mass. In India the urban population alone contributes about 15 million tonnes of solid waste generation per year. The cost involved in the collection and disposal of urban solid wastes is about 200 million rupees.

Solid wastes are generally disposed of by anyone of the following methods :

(1) Sanitary Land fill

The material is spread in depressions alternating with layers of disposal of sand or soil. The waste is thus buried. When rain water percolates the ground there will be reaction and the groundwater system is polluted. When decomposition is progressing bad smell occupies the air and bacteria, fly and mosquito growths are induced.

(2) Composting

This involves a step of actions. First compostable and non-compostable material have to be separated. Then compostable material is ground and allowed to become humus by bacterial action. By this method nitrogen, phosphorus and potassium can be recovered and could be used as fertilizers.

(3) Incineration

A method increasingly used in many western metropolitan areas is incineration. This is a complex method of burning the wastes. At the end of the process the solid waste is reduced to 80 to 90% of its original size. Incineration is done at temperatures of 760° - 980°C by which metals such as iron, aluminium, zinc, copper, lead, tin, etc, industrial gas such as carbon-di-oxide, oxides of nitrogen and sulphur and steam are separated. These products can find reuse after improvements.

(4) Recycling

Metals, glass, plastics and rubber can be recovered by this method and can be put to reuse. For example, now in

our villages and towns hawkers come and buy the worndown plastics bags, containers, buckets, etc. They melt it and produce certain products which require low quality plastics. Plastic (nylon) wire ropes, plastic bags and comb and pen are produced in this way.

(5) **Reuse**

This kind of waste disposal is in use in many underdeveloped countries. For example, we never send out automobiles to junk yard; never throw away bottles and tin containers of oils, medicines and foodstuffs. They are re-used by which process the waste disposal and the associated pollution problem is avoided. But in western countries this has been introduced in recent years.

Solid wastes are from many sources. The urban and industrial wastes which pose disposal problems (which is discussed above) are contributing only a fraction of solid wastes in our country. Solid wastes accumulating due to mining and agricultural activities are larger in amount and are not posing disposal problems; but pose a danger to environmental quality. Table 10.4 presents some of these problems.

Table1—0.4

Solid Wastes

Types of wastes	Sources	Wastes	Problem
Agricultural	Digging well	Stones, Dust	Destruction of soils, interference of water table-Drainage
	Saw dust, Baggage stalks	Bio-degradable	Soil covering fertility deterioration.
Mining	Mining Asbestos, Bauxite, Iron-ore, Copper.	Residue of minerals and crushed stones	Destruction of soils, interference to geomorphic and climatic processes.
Industrial	Chemical, Metallurgical Engineering industries	Chemical compounds Scraps.	Health problems Soil deterioration smell.
	Brick-tile Klin industries.	Brick-tile plant waste	Squatter barren lands
Commercial and urban	Building Destruction Litho printing Electroplating Container disposals - glass sheets-use garbage	Building wastes clays, glass wastes, chemicals	Squtt Space contamination, Bad smell
		glass splinters bio-degradables	Small, disease causing viruses. Problem to ground water

Biocides

Various weedicides and pesticides are called biocides. Biocides include a variety of chemicals for the control of unwanted vegetation, insects and small animals. Biocides include :

(1) Rodenticides to control rodents such as rats. rabbits, ets.

(2) Fungicides are frequently used to destroy the rusts of fungus on plants.

(3) Herbicides are used to control plants which are comparatively unwanted.

(4) Insecticides are used to control various flies, moths, tormitus, cockroaches and other insects and worms.

The most important disadvantage of the biocides is that they do not vaporize, wash away or decompose quickly. After the application the residue of the biocide accumulates. In subsequent applications the amount of accumulation will get increased. In due course of time they are able to produce their derivatives. Another important hazard from the biocide is that they affect animals and plants which are not intended to be the target. The most serious danger to the human beings is that they pose a health hazard. It has been reported that the biocide can cause even abnormal changes in brain-wave patterns. They affect the central nervous system when the accumulation in the tissues cross thresh-limits. More of human milk in most of the developing countries contain 0.15 to 0.50 ppm of DDT. This will accumulate in the cells of children who are fed the milk. The accumulation is able to cause cancer, to the young people in the coming generations. Similarly, the agricultural people who are in contact with this are endangered with serious neurological problems.

The herbicides and pesticides are chlorinated hydrocarbons. Some of the known biocides are DDT., hepta-

chlor, Lindane and Endrin. DDT is known for its Malaria control and ether small insects like fils, ticks, cockroaches, etc. control. When it was sprayed for malaria mosquito control, it brought unimaginable wonder to the world. But simultaneously it killed the other insects which were involved in polliration process and other predator animals. This brought lowering of agricultural returns and flourishing growth of pests which adjusted their life pattern to DDT toxine. The application of DDT in USA, Canada brought rabies, eagles, cancer and depreys to almost extinction level. DDT which was used to control sea flies like grats in California endangered the life of fish and other marine organisms. An accumulation of 1 ppm for four hours can decrease plankton growth and 0.001 ppm accumulation in eight days can kill blue crabs.

Another important problem in the developing countries is the pesticide casualities. Recently (in Dec, 1978) the experts of W.H.O.. who met in Geneva, indicated that more than 500,000 people are killed by pesticide poisoning every year. The committee also indicated that people use empty insecticide cases for storing food or water. Further some have even used the poison as a hair spray or as medicine for heeling the wounds. This has also resulted in many deaths.

Noise Pollution

Noise can be defined as any sound that is undesirable for the individual or community. Noise disturbs particularly man outdoors, in doors and on the job. It is a growing environmental problem in industrial and urban societies. Intense noise is generated by heavy industrial, and aircraft generations Like industrial, commercial and business activities also at times generate undesirable sound pollution.

Even domestic or social noise, such as grinding of rice or crying of child, is capable of producing such physiological effects such as mental strain. Noise is also able to disrupt job performance. To a certain extent, industrial accidents,

result due to noise pollution. The buildings, which are situated near the aerodrome, lose their property value at a faster rate.

Noise is able to damage the behaviour and habitation pattern of the wild animals and plants. For example when a road penetrates through a forest, the wild animals will migrate further away from their original habitat. Sometimes, if they have to cross the road for water, they have to search a new source and in this process they fight for survival. Shock waves, which is the biproduct of noise pollution is able to affect weak geological structures. As a result mild tremor or land slides can occur.

Noise is also an inducer of health problems. Hysteria, depression, hearing loss, tension, high blood pressure, speech retardation, sleeplessness and headache are some of the ailments related with excessive noise. Therefore noise is considered to be one of the dangers of modern society. Without noise most of the modern machines, transportation etc. cannot work but without modern machines and amenities man cannot survive. Neverthless noise can be brought down.

The Table 10.5 presents various degrees of noise pollution. Here noise is measured by a ratio called deci Bele (dB). It is 10 times the measured intensity of sound relative to perceptible sound to human ear. From the table one can understand, that how worst is our living environment. If the level of loudness increases to 85 dB one has to wear 'ear dependers' to save from loss of hearing. If it exceeds 130 to 140 dB which is the threshold limit then noise is likely to cause severe pain.

Table1—0.5

Source			Nature of noise	Loudness of noise
Outdoor	Industry	Home		
Military jet bake-off Concorde take-off	Hydrolic press metal plating	—	Highly un-comfortable	130 dB
Unmuffled motor-cycle Rock-N-Roll Band	Newspaper press	Construction work (Compressors Hammering)	Very loud	110 dB
Car wash Diesel tra-in Truck, inside subway	Stone crushing, oil mills. Rice hullers	Children whistle, Heavy grinding,	Loud	90 dB
Passenger car Air-conditioning	Old Type-writers, Tailoring Machi-nes	Loud chat Loud laugh	Moderately Loud	70 Bd
Transformers	Electronic punching machine	Conversation	Normal	60 dB
Small bird calls rats	—	—	Quiet	50 dB
—	—	—	Just audible	40 dB

11. Health Hazards

Ecology and Health

There area number of geographical factors which influence and sometimes even determine the health and reproductive capacity of living beings including man. Thus ecology which is the science of intricate web of relationships between living organisms and their living and non-living surroundings is directly related with the human health problem. The impact of environmental deterioration on health is subtle often becoming apparent only after the lapse of many years. Today we are witnessing the impact of environment on the physical and emotional health of several million people. Air pollution and its tie to emphysema and chronic bronchitis is becoming more evident. We all know very well that these two diseases are major causes of chronic disability, loss of work days and mortality in industrial nations. We have ample evidences to show very high frequency of diseases in cities, than in non-urban environment. For instance in major urban areas major malignancies of the digestive, respiratory and urinary tracts have been established.

Our main concern here is to understand the emerging health hazards due to human interference with the environment.

DISEASES FROM ENVIRONMENTAL POLLUTION

Air Pollutants and Cousequent Diseases

Chronic bronchitis, pulmonary emphy sema and cancer of lung are epideimologically associated with air-pollution. Chronic bronchitis results from the over-secretion of mucus in the bronchial lining and characterized by chronic cough to get rid of the excess of mucus.

Pulmonary emphysema is a progressive destructive change in the alveoli. Finally the use of lung is reduced leading to death. Lung cancer is another respiratory ailment in places of air pollution. Edema is a condition where excess of fiuid accumulates in the body tissue. Pulmonary edema refers to excess fluid in alveoli. Pulmonary fibrosis is the thickening or toughening of lung cells. Pnuemoconiosis is the retention of foreign particles in the lung. Silicosis and asbestosis refer to the accumulation of silicone dust or asbestos.

Particulate matter like asbestos, cadmium, lead and beryllium breathcd in our lung are intrinsically toxic. Some of the particles from smoke are carcinogens, - the agents that cause cancer. Sulphur-di-oxide and sulphuiric acid aerosol are not systemic poisons, but they are the irritants of lung and nasal surface. They evoke constriction of bronchi. This results in increased nasal airways resistance. Sulphur dioxide combined with suspended pollutants can kill persons with weak respiratory epithelial surface.

Carbon monoxide harms the body by interfering with oxygen transport from the lungs to the body cells. While normally oxygen is picked up by haemoglobin, carbonmonoxide interferes by showing affinity to the cells. Brain and heart are greatly affected by carbon monoxide. Headache, drowsiness and death are the steps of carbomonoxide poisoning process.

Photochemical pollutants and their precursors like hydrocarbons and oxides of nitrogen produce many irritants to eye, lung and bronchi and thus damage them. Ozone can cause inflammation, haemorrage and pulmonary edema in animals.

Lead is a systemic poison, causing anemia, causing malfunction and tissue damage in brain. Asbestos as an occupational health hazard, produces diffuse fibrosis of the lower lung, calcification of plueura, lung cancer, shortening of breathing etc. Beryllium poisoning

affects mucus membranes of the eyes and lungs. Metallic mercury is the enzyme poison. People in Japan experienced poisoning by eating fish which have concentrated mercury in their systems which were released from the industrial effluents.

Polycyclic organic compounds, from coal combustion can cause cancer. The large number of cancer deaths in urban areas could be possibly due to increased air pollution. Arsenic can cause cancer in the skin. Nickel fumes cause allergic dermatities. Thus while human mortality from infectious diseases is on the decline, sickness and mortality from environmentally related disease like respiratory distress, and cancer are on the increase. Thus reduction in air pollution can reduce the cost of medical aid. The persistent chemicals which are not biodegradable like chlorinated hydrocarbons that were used to control insects, have their evil effects only after their accumulation and magnification. Some of them are carcinogenic or cancer causing. Many of them induce internal bleeding, respiratory distress and behavioural disorders.

Communicable Diseases

Communicable diseases like cholera, Malaria and Small-pox are mainly due to deteriorating environmental conditions in a particular place. Let us explain some of these diseases which are common in India.

Cholera is a disease which manifests itself in an acute diarrhoea of watery, non-faecal stools causing loss of salt in the body. Death is common and results from dehydration. It is a communicable disease. This disease cannot ries spontaneously. For instance a German scientist namely Koch has indicated, "It is only in the intestines of man or in highly polluted waters, like those in India, that it can grow". Thus it is clear that environment plays an important role in the outbreak of cholera.

Table shows the mean death rate from Cholera for selected districts of Tamil Nadu :

Table—11.1

	Death Rate (Per 1,00,000 persons 1960
Madras	6.59
Chingleput	2.30
South Arcot	3.87
Madurai	2.69
Tiruchirapalli	4.42
Tirunelveli	4.46

It is clear from the table that Madras urban area has high death rate and this is obviously due to urban environmental problems. The W.H.O. Committee on Cholera believes that cholera can occur if vibrious are introduced in any part of the world where overcrowding and poor sanitation exists. Madras city and Madurai city have been reporting the round year cases of cholera thereby indicating an increase in urban incidence, increasing with the rate of urbanization. It is possible to conclude that the natural environment create favourable conditions for the incidence of cholera, man's cultural environment helps its proliferation. For instance, creation of poor water supply in rural and urban may stimulate cholera.

Now let us take the case of Malaria. Once it was completely eradicated in India. Now it has reappeared and it is endemic in India. This is an important waterborne disease. Though the mortality rate is insignificant, yet the rate of attacks has been increased in India.

The following table shows the notified case of Malaria in the selected divisions in Tamil Nadu:

Table—11.2

Division	Notified Cases 1974
Madras	1432
Saidapet	1292
Tiruvannamalai	2015
Dharmapuri	3151
Ramanathapuram	6599
Nilgiris	1

The table clearly shows a large number of cases in different parts of Tamil Nadu. Ramanathapuram, Dharmapuri and Madras appear to be the major focus for Malaria transmission in the state. Though occurrence of Malaria is related to a large number of factors, the key factors are climate and season. Ecology of the host are attributed to cultural factors such as house type, cooking methods, the presence of domestic animals, the type of agricultural practices, such as irrigation and rice culture etc. Cultural modifications of physical environment such as irrigation practices, excavations, well drilling, road constructions, canal embankments, forestry activity seem to provide favourable enviroment for mosquito breeding especiallyn in Tamil Nadu. For instance, in Dharmapuri Districts within the vicinity of Krishnagiri dam, several villages are attacked by Malaria in the recent years.

The other communicable diseases are common cold influenza, hay fever, asthma, tuberculosis, etc.

Community Health

Community health problems are also related to communicable diseases. Here drinking water plays an important role in the spread of diseases. Therefore, another aspect that is to be considered is the drinking water safety to minimise the water borne diseases. Filtration, chlori-

nation and boiling can kill most of bacteria in water. In U. S. A. it is recently reported that there is a close correlation between the use of 'soft' water and cardiovascular diseases. Probably the procedure of water softening or the removal of ingredients of hard water are related to this problem. It is believed that the minerals like calcium and magnesium found in hard water are responsible for minimising the cardiac ailments. But it is still an open question and needs further study. The presence of coliform bacteria in water are responsible for several environmental induced diseases. Thus environmental sanitition becomes an absolute must and the protected water supply free from bacteria causing diseases is very much needed in the Indian scene. As the majority of Indians live in villages, where conditions of protected water supply are far from satisfactory, the spread of waterborne diseases including communicable diseases are mostly prevalent. Cholera and ameobic dysentery, diarrhoea and other kinds of diseases are good examples of the lack of environmental sanitation in India. In the urban centres, ice and soda made of unprotected water can cause heath problems. Influenza, cold and communicable diseases spread mostly due to lack of protection against them. Tuberculosis, wnich is caused by bacteria could be prevented from spreading to others by isolating the patient and treating him, Small-pox, a viral disease is one which has been wiped out by very careful efforts of isolation, immunization, treatment and encouraging proper sanitation and medical follow - up.

Mental Ill-Health

Man is a psychosomatic whole. One of the consequences of overcrowding of human population it the great stress the body system undergoes in day to day situations. Overcrowding makes experimental mammals more aggressive, increase the size of their adrenals and generate in them a potential to face stress. Added to this, is the speed in life-style of modern times, of trying to achieve things faster in a competitive environment. Thus the factors of crowding, stress. speed and other aspects of society have a great

effect on their nerves. Depressions and lack of sleep are the common experiences of many. This is coupled with factors like alcoholism to forget the so-called 'misery' adds to the woe. In certain countries, 'mood changing drugs' and 'mind-benders' are made available freely by unscrupulous elements. Amphetamine, a drug that mimics noradrenaline is used to elevate the mood, induce euphoria, increase alertness and reduce fatigue. This is what we call the 'antidepressant effect'. Use of this drug, rather its abuse results in continuous cortical arousal and the person goes without sleep. Much of the 'hallucination' is due to lack of sleep. In severe cases of amphetamine abuse, the person becomes schizophrenic. and he does not distinguish reality from imagination. Tranquilizers and other central nervous system depressants like barbiturates (sleeping pills) and alcohol have led to so much of side effects that its use is hlghly regulated now. Marijuana, LSD, Hasish and other opiate drugs hallucinating drugs to reduce memory and temporarily take the mental depression. But the evil effects of their addiction may lead to death.

Radioactivity and Diseases

In nuclear power plants, uranium is used as fuel. Nuclear fission from uranium rods produces heat. This is used to heat water circulating through a boiler to drive steam turbines and to generate electricity. The fission products from uranium include radioactive waste material like Strontium-90, Cesium - 137, Radioactive iron isotopes, gaseous types of iodine, krypton and xenon. Tubes containing uranium may develop fractures or leaks, allowing the fission products to escape and contaminate the cooling water. These radioactive wastes released in effluents, may be transmitted to human beings directly through water supplies or indirectly through crop, animals accumulating in them and back to man. Frequently fuel elements of the reactor are reprocessed, when uranium and plutonium are separated and returned to the reactor, gaseous kryton - 85 is released into the atmosphere.

Any amount of radiation above the background level, causes increased rate of mutations in living system. Radioactive materials could be concentrated by animal system through food-webs. Human exposure to high doses of radiation can result in cancer, lukemia, acute anemia, cataracts loss of hair, retarded growth, blindness, epilepsy; brain-damage, shortening of life-span, severe burns and death. But any exposure to lowest level can raise genetic mutations and affect the offspring such genetic defects may include, haemophilia, allergy, dwarfism, clubfoot, harelip gene mutations and chromosomal aberrations. Increasing the dosage of radiation can cause genetic damage.

Long term exposure to low rates of radiation have shown the induction of tumour. Disposal of radioactive waste by concentration and containment or by dilution and dispersion in the environment will have to be considered carefully. Even sinking them below 1000 feet with salt may resuit in damage to life if it inadvertently gets exposed.

PART IV

Society and Environment

We have already discussed the various environmental problems arising out of human activities. It is a well - known fact that man has to act in a social set up. This social set up can be recognised as society. Thus society seems to be a guiding factor in some of the social activities performed by man. Social interaction is nothing but the reciprocal response of one individual's social act to that of another. Thus social interaction is basic in human adjustment. It is also a well-known fact that biological characteristics make it impossible for man to live alone. He is dependent upon others. Such a social interaction in a society is likely to create a changing environmental landscape. The social interaction can be identified in the form (a) get together (b) marriage (c) fairs and festivals (d) Shandies or rural weekly markets and (e) leisure activity etc. All these have their own impact on environment. Let us take the example of fairs and festivals in rural areas. Here people meet together and spend their time in a given space. This space is likely to act as an originator of communicable diseases, such as cholera, small pox etc. Thus local environment is likely to be affected by the social activity.

In the modern world we have more complex societies involving in different social interactions. Thus development of society and the changes in environmental set are complementary to each other. In the following section we discuss two important phenomenon of society:

(A) Culture.

(B) Recreation.

12. Culture and Environment

Man gets his physical characteristics by heredity. By heredity means the biological process by which the physical traits like stature, colour, shape of head, colour and texture of hair, colour and shape of eyes, shape and form of nose, and the like are passed from one generation to the next. That is to say, the physical traits, with which only homo-sapiens are grouped into races, are genetic and inherited ones. The man who is born with his own physical characteristics is brought up in a society or a group. So he acquires his way of doing things and his behaviour pattern from that society. In other words, he learns the accepted ways of the group from his parents and other fellow-beings, thereby becoming one amongst it. This set of behaviour pattern and way of living acquired by learning and by heredity is called the culture. It is the norm or the standard of that society and according to them only he lives and behaves.

Generally, the term culture refers to totality and the cultures, the parts of totality, as it is an assemblage of a number of cultural elements. It includes elements like beliefs and other traditional ideas, customs and manners, morals, languages, arts, knowledge, skills, laws, government, and so on. It is not a static one. It goes on changing and getting refined or new elements are added, as the group gets more and more experiences in the course of time. The cultural elements which become so conspicuous and distinguishable in the course of time, are known as cultural traits. A large assemblage of cultural traits results in cultural complex and of cultural complexes, in a cultural system. The progress of culture from simple to more complex and refined one is described as civilization.

Cultural Process and Change

The culture develops in a group through several cultural processes that just indicate the actual social mechanism by which the cultural change takes place. The basic processes are discovery, invention, evolution and diffusion. Discovery is a process of finding something naturally available and then discovering a utility for it. Invention is a process of creating something new from the naturally available materials. Finding iron ore from the earth is a discovery and manufacture of steel from it is an invention. Evolution refers to the process of adding something to the set of practices, tool system, and the like already in operation. The progress of shifting cultivation to hoe-culture is an evolulionary process. Diffusion is the procees by which the cultural elements spread from one place to another. These four basic processes seem to be a chain process. A discovery generally leads to an invention; an invention gets improved in the course of time and there occurs an evolution. During the evolution, an invention normally gets diffused.

As already noted, the pattern of culture of every human society is constantly changing. The change may be slow and gradual or fast and drastic. For instance, it was dead slow in the paleolithic societies and it is terribly fast in the present ones. There were few periods of great change in culture and they are called the periods of revolution. There occurred four periods of revolution in human society :

1. the period when man learned to use fires and tools ;
2. the period when he learned to cultivate the plants and domesticate the animals ;
3. the period when he framed laws and formed governments ; and
4. the period when he staged the industrial revolution.

The changes in culture of every human society are effected by many factors :

1. Natural environmental changes like the retreat of glaciers and the sea-level changes may lead to a change

in cultural pattern, as they open a new environment for the people.

2. A new invention may cause a change in culture. As an example, the fast changes going on in our agricultural practices now have resulted from the invention and spread of technological inputs.
3. Any evolutionary change taking place within the society may also change the cultural pattern of that society. Evolutionary change here means the adaptive change in the wake of new development. For instance, food-surplus in some areas thanks to the green revolution, the requirements of food-producing technology and the population growth bring about new problems to the society, demanding changes in cultural pattern; as a result, there comes a need for social control and public distribution of commodities, a change in marketing, and so on.
4. Any contact between two societies may encourage the diffusion of cultural elements, thereby causing cultural changes. The changes now going on in the tribal culture are mainly due to the tribal areas now opened to the outside world.
5. The migration of a society from an ecological zone to another may also bring about a change in culture, both in the migrants and in the group with which the migrants are settling down.
6. There may also occur a cultural change, when a society is conquered by another in war. For instance, the Indian culture got a number of changes largely from the Muslim and the British rulers.

Culture and Personality

Personality of an indivldual constitutes yet another factor in the cultural process and change. Here it refers to the individual's individuality that is his personal characteristics and capacities. It is mutually related with culture. Their degree of relationship is contigent on the personalities of

individuals constituting the group. The relationship here means how an individual reacts to the culture of the group which prescribes the norms and rules for his way of living.

He first cognizes the norms and rules of the group's culture; then he learns them in detail; he evaluates them; and finally he adopts them to follow. These processes are essential for him to perform the customs of the group properly. The customs in turn regulate his behaviour pattern and directs his way of living in consonance with the group. During the process of adoption of the customs, he may get satisfied or he may get agitated with them; all depend on his personality. As is known well, man has a greater degree of biological plasticity and cognitive ingenuity and so he can conceive any form of behaviour and way of living. That is to say, his behaviour pattern potential is so enormous. This much of behaviour pattern potentils is more than required for living in group. So he has to restrict his own thinking and ideas so as to live in harmony with his society. Many a time he doesn't go well with the customs because of his greater behaviour pattern potential and because he doesn't restrict his own ideas and thinking. In other words, what he must do according to the culture may conflict with what he would like to do. This conflict often brings about struggle and frustration and then leads to tension between individuals and culture. The conflict and tension varies in magnitude from person to person because of the differences in personality between the individuals. In course of time, it may change and shape the culture, when it becomes more powerful. There are a number of instances for this in the human history. In fact, culture was initially invented to achieve adaptation to environment and changes in it thereafter were and are effected by the personalities only.

Diversity of Culture

The four basic processes of culture, the factors of cultural change and the factor of personality outlined in the earlier sections are all operating all over the world but not in uniform degree or strength. Neither do they operate with the

same time schedule. As such, stages of cultural development are also varying. The result of all these varying operations is the diversity of culture and not a single one for the human race as a whole The operations are varying mainly because of the fact that culture was developed to exploit the natural environment in relation to the sources of food and shelter, to systems and operational procedures and that natural environment differs from plact to place. Thus there resulted in the inhabitation of a great many cultural groups on earth. In our country too, there are a number of distinct cultural groups.

Cultural groups before industrial revolution almost lived the isolation. The rapid development of communication lines, thanks to the industrial revolution, brought various cultural groups much closer. Of late, because of the increasing contacts between cultures the sheer variety of cultures on earth seem to be dissipating slowly. The spread of styles of Western society across the world is gradually removing the unique differences of culture. Of course, it is a slow process and may take centuries to come. Anthropologists say that the cultural variety was on peak in the 14th and 15th centuries before Europeans have seriously stepped into the ways of life of people of other continents.

Cultural Regions

Each cultural group settles down in a specific region of the earth and acquires its own specified and distinctive system of culture. These regions are called cultural regions and sometimes referred to as cultural areas or cultural realms. It is identified that at present there are seven cultural regions in the world. They are American Culture Area, European Culture Area, African culture Area, Main Islamic Area, Soviet Culture Area, Oriental Culture Area and Pacific Culture Area. The American Culture Area includes countires of Anglo-America and Latin-America and is largely of European in origin. European Culture Area lies in the west of east European countries. The African culture Area occupies the whole of Africa except the North. Main Islamic Area falls in the great belt of deserts extending from Morocco in the West to Pakistan in the east. The Soviet Culturc Area includes

USSR and the East European countries. The Oriental Culture Area covers the countries of southern and eastern Asia. The Pacific Culture Area spreads over Australia, New Zealand and other Pacific islands.

Cultural Impact on Environment

Human culture, as sketched earlier, includes methods and skills of material culture. The material culture is developed for making use of the resources available in the natural environment and without exploiting this resource base, no human race can survive. As such there is a close connection between the culture and environment.

Man is an active-being, moulding his environment both geologic and biologic, according to his living style. His moulding or change of environment is what we mean by cultural impact on environment. The cultural impact on environment nowadays is a topic of concern because of the interference with the environment, thereby disturbing the whole ecosystem. It is true that change is a normal or natural phenomenon and is continuously going on both in geologic and biologic realms. For instance, rivers are continuously moving the earth materials from land to sea; they carry away not less than 100 million tons of earth material in solution and suspension every day. Thus geomorphic processes and other cataclysmic processes are continuously working on the earth. Similarly the biologic realm is also under a continuous active process of change. These are all natural impacts on environment. The changes man brings to the environment through his cultural development are cultural impact. They often differ from the natural changes and further man's actions very often accelerate the change activated by the natural processes. Man's impact on geologic realm may not be significant but with biotic realm is almost a total one.

Cultural impact on environment has resulted in a number of material benefits to the human society and at the same time has brought some problems too. It is determined by the level of cultural development and so varies spatially and temporarily. People with less cultural development identify limited resource

base only and make less impact on environment. Their relationship with environment is not a dynamic one. People with cultural advancement, on the other hand, register a greater impact on environment because of the technologies providing them means for exploiting the potential environment. Their relationship with environment is thus a dynamic one. The differences on the cultural impact between the European Cultural Area and the Oriental Cultural Area or simply between the developed and the developing countries, have resulted largely from the differences in the levels of cultural development.

Man's inteference with environment actually started with the introduction of cultivation. He initially followed shifting cultivation that is a slash and burn type of cultivation. In this type of cultivation, not much of damage was done to the biotic environment, as the cultivation was not done in a plot for one or two years only. When shifting cultivation was developed into agriculture, man's impact on environment has been noticed. Because of the large scale and continuous cultivation in agriculture, soil erosion has been acceleraled. For instance, in 1977, it is estimated that more than 2 billion tons of top soil was washed away from crop lands in United States. The introduction of agricultural chemicals and the development of irrigation have lured farmers to do away with the old system of crop-rotation and the result is the decline of soil fertility. It is said that the fertility of a fifth of earth's crop-land has declined alarmingly. The modern cultivation has undoubtedly increased the agricultural output and at the same time resulted in a considerable damage to the environment. For example, the use of agricultural chemicals in the fields has led to the pollution of water in ground, rivers, lakes and seas.

Rapid industrialisation and urbanisation are related with advanced and advancing culture. They have resulted in all kinds of pollution. Cities in the countries of advanced culture present the worst location of all possible environmental problems like air pollution, garbage, sewage, and minimal recreation areas. In the developing countries too, fast

growth of urban population resulted in the mushroom growth of slum and squatter colonies in the cities.

Besides the material culture, non-material culture like cultural traditions, also determines the man-environment relationship. The traditional practices followed by a cultural group may have an impact on environment, positive or negative. This fact may be understood with two simple and common habits we have. Our custom of cleaning the street area in front of our houses with water early in the morning is the one helping to keep environment clean. The habit of attending natural calls in the surrounding open places is the one aiding the environment deterioration. Another interesting social custom of ours is keeping cattle within the visibility of houses in urban areas. This promotes health hazards.

In most of the developing countries, though environmental problems have cropped up and are slowly enlarging, due to urbanisation and industrialisation, people are yet to be aware of the problem and their perception is not sufficient. This happens because our non-material culture hasn't developed in pace with the material-culture development.

13. Recreation

In the foregoing section we have already discussed man's cultural progress and its relation to environment. In this section we shall try to emphasize the role of recreation in the changing environment. Recreation is not a new phenomena. Right from the historical time man used to spend his leisure time in swimming, hunting and visiting places. He was always cherishing the scenic beauty of natural environment. However, today the "cultural revolution" which encompasses all the social and technical changes has given a new dimension to 'recreation activity'. In other words recreational behaviour is also considered an important economic activity. In the context of modern society it is an important as coal mining, dry farming or any other economic activity. It also plays an essential role in transforming the country side into a dwelling place or livable habitat. However it is rather difficult to explain whether recreation as an economic process has the same kind of spatial expression as do other goods and services.

Today the environmental scientists strongly feel the problems arising out of the interaction between man's leisure time and the environment. One would really like to know whether this activity has an impact on the environment. Does it really affect the ecosystems in an area susceptible for recreation?

If one has to answer these questions, there is a need to understand the behaviour of man towards leisure. Modern technological developments have certainly changed his outlook towards the spending of time in search of various kinds of recreation.

Let us take the example of modern rapid system of transport facility available to man. This system makes man more mobile. In other words if a man has little bit leisure

time, he is prepared to travel for a long distance in search of recreational facilities. Therefore, the recreational spaces are no longer oriented towards the habitat site. Thus there is a search for good scenic areas in the country side. On the other hand one could also visualise the problems faced by these type of scenic areas. For instance rapid urbanisation and industrial encroachment on countryside and deforestration etc. sometimes destroy the available natural scenic areas. In the same manner over utilisation of resources around scenic areas for recreation purpose may indirectly aflect the ecosystem of that area. The best example is the Ootacamund lake in Ootacamund area of Nilgiris district in Tamilnadu. This lake had a good supply of water from the hill slopes of the adjoining areas. Around the lake good vegetative cover was there and in fact the lake and its own ecosystem. In order to cater to the needs of the tourists, several areas adjoining the lake cleared for the purpose of constructing roads and parking spaces for vehicles. This has resulted in the increase of soil erosion and silting of the lake. This is how the deterioration of the environment takes place, All these clearly indicate that there is a need for cautious approach in the planning and development of recreational areas. Therefore let us give more emphasis to the understanding of the growth recreational activities and its impact on environment with special reference to countryside.

Resource for Recreation

Before we explain the above said phenomena, it is also essential to understand the potential recreational spaces both in rural and urban areas. The physical environment appear to dictate the absolute level of supply in terms of resources for recreation. On the other hand the cultural environment which also pays an important role in the supply of resources include historical sites, temples, fairs and festivals, library, club, theatre, fine arts academy, theatre for performing arts, and other social institutions.

The Recreational Spaces

The recreational spaces can be grouped into three cateorgies. They are :

(a) urban oriented
(b) countryside and
(c) culture oriented

For instance the urban oriented recreational spaces are parks and play grounds, areas occupying theatres, clubs and fine arts societies, open spaces like beaches, lakes, rivers and tanks etc. The countryside oriented are waterfalls, forest areas, hill resorts, gamc and bird sanctuaries, scenic beauty spots such as estuaries, bays and headlands, hillocks, lakes and ponds, tanks and rivers, confluence of rivers, cliff scenery, backwater areas etc.

The culture oriented spaces are shandies, temples, forts and public buildings. In the case shandies and temples though people visit these areas for specific purposes, yet they do not look as recreational areas. For instance trade fairs provide sufficient leisure time activities. Similarly large open spaces and tanks within a temple complex can certainly attract people for leisure time activities.

All the physical recreational spaces do have their own ecosystem. In the economic process of recreational activity these systems are likely to be disturbed. At the same time these recreational spaces do attract a large number of tourists, thereby the area development process gradually sets in. Thus the space becomes an economically active space. This process leads to another important function viz., "Creation of resources" in these recreational space. The term creation of resources refers to the development of restaurants and lodges, hole's and motels, cinema theatres, amusement arcas and shopping areas. It is these new resources, if left unplanned, create more and more problems in the development of recreational activity. Though these resources are essential for the recreational activity, excessive unplanned growth may affect the ecosystem of the area. In a developing country like India, we see more mobility towards urban oriented recreational spaces even from the rural areas. It is because of this ecologically significant recreational spaces urban areas

and its environs are under constant threat from the "creation of resources". As the frequency of mobillty towards countryside is not that significant, we have not yet felt the impact. Thus we conclude the operationa of such resources more vigorous in urban oriented recreational spaces than in countryside oriented recreational spaces.

Growing Concern of the Quality of Recreational Spaces

In the present world, it is felt that recreation is playing more and more important role in the cultural life of the people. It is because of this, more and more area both in urban and country side is being identified and used as recreational spaces. In this connection it is possible to conclude that this economic process is essential for any development process in a region. But at the same time one should also be careful that this economic process should not over explore the natural environment and the related ecosystem. The following objectives should be kept in mind while identifying the recreational spaces in the countryside :

(a) To make it easier for those seeking recreation to enjoy their leisure in the open area without travelling too far; avoiding the congestion on the roads.

(b) to ease the pressure on the more remote and solitary spaces having unique ecosystems.

(c) to reduce the risk of damage to the countryside, aesthetic as well as physical.

The other important step is to know the level of use in terms of recreational activities for the purpose of proper planning. Further, this evaluation will also help us in checking the further damage to the existing ecosystem in any place. On the whole the capacity of the area for recreational purpose can be viewed in terms of ecology because the capacity of vegetation cover to support recreational use without deterioration is our motso. Now let us see what are the potential areas which are susceptible for disturbance.

These recreational spaces are :

(a) Developed or proposed resorts
(b) National water parks and forest parks
(c) Community parks; major scenic route with facilities
(d) Special conservation areas
(e) Heritage sites
(f) Transport routes and interchanging points

The ecosystem in and around these places should be carefully studied by the environmental scientists.

Problems of Recreational Development and Need for Balanced Development

So far we have discussed the role of recreation in society and the relationship between the recreation and the environment. We have also realised that if there is no proper planning, this type of human activity is likety to disturb the natural environment and ecosystem.

Let us give an example for the deterioration of environment. Ootacamund is an important hill resort in Tamilnadu. During the British period the site was identified and developed into a nice summer resort. With good vegetative cover- the area possessed adequate water resources. No doubt this area developed into a good recreational space for the tourists. But for the past three decades are so rapid urban development and migration of people to this area have brought the following problems:

1. deforestation and hapazard development of habitat sites
2. Urban encroachment on the countryside
3. accumalation of more and more administrative offices
4. Hapazard way of filling up of open spaces with theatres clubs, restaurants, shoping and other social institutions.

All these factors have completely spoiled the scenic beauty of the urban area and its environs. Apart from this one is also able to recognize the water shortage, soil erosion and

andslides in these areas. Thus the quality of recreationall space within the area has deteriorated to a large extent. One has to search for the same In the far away places from the town.

Once again we look into the condition of Mahabalipuram, a historical site near Madras: we will be able to identify the creation of services in and around all places of this site. This has stimulated the growth of a variety of shopping centres and restaurant around the historical site within the proximity of beach. No peaceful leisure time is possible within the above said site

In view of these facts, the following basic planning precautions have to be kept in mind before the exploitation of extensive areas of beautiful wild countryside:

1. Characteristic landscape should be strictly preserved.
2. Access and facilities for public open air enjoyment should be amply provided.
3. Wild life and buildings and places of architectual and historical interest should be suitablly protected.
4. As far as possible the existing ecosystems in these areas should not be disturbed.

One of the ways of protecting the environment is to assess the optimum use of land in differnt areas. The term optimum use here refers to the use of land for a specific purpose without disturbing the already existing balanced ecosystem. This type for delimitation of land is known as landuse zoning. District landuse zoning is a proper solution to the various problems of the changing environment.

PART V

Protection of Environment

Though we have realised that we are facing a deteriorating environment, it is our duty to learn what can be done to correct the mistakes that have led to the current condition of the environment. The long range environmental improvement must take into account complex interactions of environmental processes. In future the effects of man's actions on complete ecosystems must be considered as environmental problems to be solved. Each environmental problem should not be treated in an ad-hoc fashion. Strong lasting interactions between various parts of the problem should be considered for the purpose of planning. Another aspect is to create an awareaness among the younger generation about the growing environmental problems. Every citizen should be aware of his local environment atleast.

14. Environmental Planning

Definition of Environmental Planning

Environmental planning is a comprehensive approach to the use and management of "natural environment". We have seen in the foregoing chapters that most of the human activities have an effect on the use or development of land, air, water and wild life. But unfortunately there is no form of control to streamline these activities. Environmental planning tries to act on this end. One of the biggest problems in this planning process is that none of the aspects of the environment could be treated in isolation. This is mainly because all these aspects interact in varying degree and hence the environmental problems become more complex. This calls for an urgent coordination in this direction.

Need for Conservation, Protection and Planning

We have seen that the environment that surrounds us is not a mere mass of inert materials. Therefore, it cannot be manipulated as we like and according to our cesires. It is a delicately balanced system. It tends therefore to attain a state of equilibrium under natural conditions. This equilibrium or balance is one in which various interacting components reach a state of adjustment. This adjustment is directed towards various factors in operation. The factors include the climatc, the plants, the animals, the soil and others. Each one of these influences the other directly as well as indirectly. For instance the apparently inert soil layers influence not only the plants which grow it, but also the atmosphere, the hydrosphere, and the biosphere. Interfering with the soil surface will inevitably cause changes in its capacity to sustain plant life, and in several other aspects.

Thus, tampering with the environment has its hazards· Since man is intimately bound up with many factors

constituting the environment, he has to recognize his depedence on the system. For in damaging it irreparably, he irreparably damages himself.

His activities tend to interrupt and at times greatly accelerate the natural processes taking place in the environment. Thus certain circumstances give rise to a whole series of irreversible changes. So, man's activities constitute a constant source of disturbance of the environment which if undisturbed would tend to reach a natural state of balance.

Modern technology and present day human organization enable man to interfere with the environment on a vastly larger scale than in the past. And there is therefore great danger of causing immense harm by the misuse of these means. Action taken without due consideration of the inherent dangers may start a series of irreversible changes or trends in the environment. This often times culminates in a serious or even permanent impairment of its productive potential. It is this that necessitates a need for systematic and active planning for environmental protection.

From what has been said thus for, the urgent necessity for planning the environment needs no emphasis. It will provide both the Government and the people with badly needed basic knowledge and expertise which are quite essential for sound policies and safe decisions. This will help avoid deleterious changes in the environment.

Environmental protection and restoration of balance will have to be planned on a long-term basis. The aim in all this must be the attainment of a state of balance in the environment, with a minimum of human interference to maintain it. Let us explain need for environmental protection with the help of resource utilization in India.

Resources and Utilization

At present, in India, there seems to be no provision for reviewing and systematically replanning the resource utilization. Apart from the programmes for bringing resources into use wherever possible and the programmes for the extension of

already used resources, there seems to be no plan or proposal for utilizing thc others in any other fashion.

For instance, a large proportion of the uncultivable lands lies on the sloping, uneven upland areas. But yet forested areas are cleared and utilized without discrimination. It is what is happening in the Nilgiris and other hilly tracts of the country. These upland areas play an important role as zones of percolation for the rain which they receive because of vegetation. And thereby they contribute a part of the ground water supply which is tapped and used at lower levels. Indiscriminate felling and unregulated activities in these areas not only affect the local vegetation but even the surface drainage and subsoil water conditions.

Soil erosion may thus be accelerated and greatly increase the risk of floods and of damage through sand casting of cultivated fields in the foothill zones. Since, soil erosion and serious damage to the upland can happen very quickly restoration is a much slower process. It will be best and most essential in the long-run to anticipate them by adopting preventive measures. This can be done by planning the use of all upland in terms of the natural units. Integrated planning for each natural unit should not only provide for the specific use of each of the components but also allocate appropriate uses to each category so that balance is not upset, And wherever possible, planning should try to increase the potential productivity of the area.

There is need to have a rational land use pattern, distinguishing land for intensive cropping, for natural reserves, and multiple uses. This land use pattern should ensure survival of many elements of the environment and the cost of conservation may at least partly be met by the sale of products. It is also necessary to secure the release of less productive land divert it other long-term uses like regulated grazing, afforestation and tree crops. It will be more effective lo concentrate on high productivity in selected areas than on low productivity spread over the entire land. It is equally important to maintain and secure environmental variety in the

plant and animal species and even in landscape characteristics. That is, planning and management should be so arranged that nothing irreplaceable is destroyed.

In India, the growth of population has transformed the economic situation by making labour the most abundantly available factor of production. And land water have become much scarcer comparatively. In this situation, schemes have to be devised to utilize labour most intensively, land in less measure and water even more economically. Comprehensive and continuous collaboration with agriculturists, foresters, industrialists, economists, geographers and others is much needed for land use and man-power planning on an emergency footing.

There is however very little active interest and awareness among the population and even among the educated. The inadequacy of planning education at all levels leaves us incapable of appreciating the significance of what we see in our environment. There is thus urgent need to arouse public awareness and public participation over the environmental damage and environmental planning. The absence of any definite policy regarding popular participation in planning processes, formulation, and implementation appears to require amendment to help accelerate the proper use of the environment and its resources.

A good deal of environmental damage results from the widespread lack of understanding of the role of the environment in all human activities. The awakening of public interest and participation in the environment is thus very much needed to counteract and put an end to the various activities deteriorating the environment.

A programme of publicity suited to different social, and educational levels has to be organized. It should also be sustained over a long period of time to ensure its tmpact to have lasting effect on the public. The rural areas will need a largely different programme both on account of the difference in the educational level and on the varying characteristics of

the environmental problems relative to urban and industrial regions.

Environmental education must be incorporated as an integral part of the school curriculum and related to subjects such as sociology, economics, geography, biology, and civics. This must be supplemented by an intensive adult education programme through all the mass media.

It may be now worth while briefly to summarize the implications of environmental planning and protection. There are atleast three aspects:

1. The management of human environment and its social implications.
2. The identification of environmental problems and the attempt to resolve such problems, or remedial environmental planning.
3. The promotion of social welfare to meet defined sccial needs.

In all these. the environmental planner is concerned with the spatial distribution of scarce resources and their utilization. Because, there is no consensus how social welfare has to be distributed, there is an unprincipled scramble for economic benefits. Environmental planning therefore has to differentiate between different sections of society, to discriminate in favour of those in most need.

In the light of the above discussions, we can have a scheme of planning orientations. A planner may thus have :

1. Corrective environmental orientation - e.g. social redevelopment schemes attempting to correct environmental deterioration.
2. Creative environmental orientation - e.g. conservation of resources, attempting to create new schemes for environmental balance by control.

All these orientations are to a greater extent dependent on his understanding of how society operates and changes the environment.

Levels of Planning

Once we have realised the need for planning, it becomes necessary to know who plans and that too at what level. In India, one could recognise the planning agencies as government organisations which interact with several bodies such as District, State and National administrations. Planning is carried out primarly at three levels, (a) National (b) Regional State and (c) Local-District or rural or grass root level.

At the National level, the planning thrust is not only to coordinate the planning programme at various levels but to take care of problems common to various states in India. For instance, pollution problems relating to national river systems, Indian coastal areas and marine resources etc. can be tackled at s National level. At a regional level, which is mostly operated at a state level can plan for the problems arising due to rapid urbanization, industrial pollution and misuse of agricultural land and forests etc. At the lowest level such as village or a small town planning for better housing, protected water supply, sewage disposal, medical and educational facilities can be planned.

Vigilance and Enforcement of Laws

The nations of the world today. faced with massive task of cleaning up and of preventing further destruction have begun to realize that technology alone has not, and brobably connot, solvage the environment. Instead, we must alter our values inparticular our celebration of progress, if we seek for a relatively unspoiled environment. Our laws and economic structures must be changed so that productivity is no longer the ultimate measure of success. Legislators must determine what segments of society should bear the responsibility for the damage caused by the environmental degradation.

Even in developed countries like U.S., until recently had only few provisions designed to protect the environment. However, no such developed countries have realised the importance of laws and have introduced the same in several areas. For instance, the laws regulating pollution

have become significant in U.S. In August 1972, the Hudson River Fishermen Association was awarded' 20,000 dollars for information leading to the conviction of Anaconda Wire and Cable Company. which was dumping toxic discharges in the Hudson River at Hastings, New York. Another important measure taken in this direction was pollution tax. Such a scheme would encourage ecologically sound manufacturing processes.

As against the developed countries let us see the problem of Developing countries. Here thc country strives to industrialize and tries to obtain large share of international trade. Rapid industrialization levels to rapid degradation of environment. It is a fact that even in India, the environment was simply not considered during the period of rapid industrialization. Here the basic fact is that they who are poor may want to share in general wealth before cleaning the are. However, this cannot be the ultimate motto for any developing country. Enactment of laws is a must for the protection of environment. Laws must control indiscriminate use of the environment by the vested interests punishing them so that they may avoid damaging the environment in self interest.

15. Study of the Local Environment

Introduction

A local environment will be the smallest possible spaces. Local environment is easily understood as there is daily experience with it. What are included in the local environment? The type of physical features, the land use such as agricultural lands, forest lands, residential and all waste lands. Here the use of the natural environment could be observed. The fertile soil of the village has been used in the agricultural lands, the forest area has natural vegetation. Houses are built in relation to communication facilities. In general the use of the environment could be studied according to the usefulness of the various environmental factors. The constant interaction of man with his environment leads to overuse of the potential resources. For example, thc fertile land being over-used for food production, that in course of time they are found to be useless. The forest is being removed due to increase of population, occupied by houses. Develoment of the cultural features near the residential area may also be observed as a local environmental feature. The characteristics of the local environmental factors wilil vary from place to place.

What is the need for an environmental study? The environmental study is not thought of as a subject with its even body of factual information, but learnt as a way of learning through organized enquiries. It could be defined as an approach through activity based on the child's physical and social environment, which leads to the progressive development of attitudes and skills required for observation, recording. interpretation and communication of seientific, historical and geographical data. The aim of geographic study could be fulfilled through environmental study. The interaction of man to the various aspects in his surroundings leads to the development of the locality. The development will continue as far as the resources are available for use. The study

should equip the mind to observe the overuse of the local resources and the hazards in future by this. Also by using the local reserves the waste products accumulation will be creating new problems in the area. This at the initial stages will not be striking but after a certain level of development these accumulations will start giving problems in the area. In order to understand, the proper use of the environment and to learn the overuse and misuse of the environment the environmental studies is essential. The local environmental studies include the features of characteristics, changes and problems which are distinguishable from one another. These features may be traced as a consequence of success or failure of efforts to overcome problems arising from them. Hence the environmental studies attempt to identify, appreciate and evaluate the problems and suggest ways to overcome such problems.

What are the problems usually faced in the village environment. The village is a small unit of space where the various functions are simple. Most of the people are engaged in agricultural occupation. Here the environmental study will show the use of land for agricultural purposes. The types of crops grown could be observed. This will show how the local soil pattern in the environment is used for cultivation. The products are sent for the markets. This will be observed by the students by tracing the transportation lines in the village and the mode of transport. The agriculturists' dwelling will show the type of houses they live in. This could be further expanded by analysing the spatial location of the houses, the size of the village, the spread of the cultivated land and the daily movement, all will be reflected by the location of the house-steads near the fields. A constant study and observation of the village will show the change in the crops cultivated which could be a reflection of the overuse of the land of its original fertility. Similarly the development of communication lines and the modes of transport may also have a change which could be the development in the economic standards. Even the local communities and the population may be observed in the locality. In some villages, some families may

be shifting out permanently. This may further help to extend to this study of local emigration due to attraction outside the village. Thus in the study of the village, the area being small, the environmental factors are being simple and less in number direct environmental studies easily beneficial while doing this the following questions may be used to make the study easy and complete. The local study of the village environment will be completed by finding answers to the following questions:

(1) What are the local physical features you could see?

(2) Do you have more cultivated lands or others like forest etc.?

(3) What are the crops cultivated?

(4) What are the other features found in the uncultivated area?

(5) How do people go to near by areas?

(6) If they go to nearby areas for other necessities, does this village lack them?

(7) If this is a sudden occurrence, is it due to the local population increase, or the over-usage of the local resources or the unavailability of material locally enough?

(8) What are the drinking water facilities in the village?

(9) Are they safe? If not is it more of an enviromental hazard to the village ?

(10) As a natural environmental factor how is the climate helping the village ?

(11) If the climate fails what is the natural hazard felt by the village ?

(12) If the village has people, all working outside the village, what will happen to the existence of the village, as an agricultural village in future ?

Thus answers to questions in these lines will help the study of the local environment at a village level. The study of local environment at a town level will be different. This will have some more functions present within the locality.

The local environmental study of a city includes the physical features, climate, population, community, occupation and other functions. Cities are nodes where man's greatest impact on nature will be seen. The resources like land, air, organisms and water are altered to the maximum. This has created new ecosystems within which the interactions of man, his work and nature are complex. City is broadly defined here to include the totality of nutural, social and artificial components aggregated in populous places, the population has a highly organized culture including varied skills but lacking self-sufficiency in the production of energy (including food). The city may also be thought of functionally as an open ecosystem for perpetuating urban culture by exchanging and converting great quantities of material and energy. These functions require a concentration of workers, an elaborate transportation system, and a hinterland that can supply the resources required by the city and absorb some of the city's products. These definitions purposely avoid arbitrarily defining a city on the basis of a minimum number of inhabitants. We use the term urban sometimes for city. This city development takes place by modifying the local environment. The physical environment may influence the form, functions and growth of the city. There is continuous feed back between man, culture and physical environment. As a local environmental study of city the various functions could be studied. These various physical features may be studied in which the local rivers, ponds, open grounds, all may be studied according to the nature and utility. All the open ponds may not be often found in city, as it is in a village. The use of water may be studied from the various sources available. This is a natural resource of the locality, The local environment being city the process through which water is used, is different. There may be tanks which supply water through pipes. There may be bore wells which supply water or common tanks with pakka construction, which may be supplyiag water to the people. Next the different occupations which form the complex function of the place. There may be agricultural activity too, but this may be confined to the outskirts of the city limit, where the understanding of non-cultivable lands for other uses may

be studied. The location of industries in cities are important. This will vary according to availability of the local resources. The more the development of the city the more the number of ancillary industries will be. The development and use of local environment, this my also leave characteristic pollutions such as industrial wastes and agricultural wastes. These wastes may have chemical change and pollute the city. Similarly the physical accumalation may lead to the pollution of the place. For example if there is an industry using water. the water flowing after being used in the industry will contain the chemicals and suspending particles (Note : The term **city** is used for town in some places), which will be polluting the surrounding areas. This can be studied by observation. The utility of the resources leave wastes which are harmful. Similarly in the moulding industries the metallic dusts are heaped all around the factories which are again a physical environmetal feature creating difficulty to the local people. The factory areas will also create some problems from the smoke emitted by them. These factors could be locally observed and learnt. Other service centres such as ancillary industries may also be dumping the wastes close by which may lead to health hazard of the area. The expansion of facilities such as residential and others like school, hospitals and recreation also could be locally studied by the analysis of local environment. The utilisation of all the space available for the construction work leads to depletion of space available for any further development. Hence people move to the open places around the city. The residential encroachment on the cultivable lands could be studied as part of local environmental study of the town. This congestion will create other problems like the development of communication lines and too many modes used in various routes, the drainage, congestion, sewage water accu-mulation. Apart from this in a city those who provide ser-vices to the people of each area will form small slums in between. This is not only the utilization of the space available but also the hindrance they create to local people. For example, the supply of milk to the residential area. The live-stock will be tied all over the traffic roads, the dungs being accumulated or dried for fuel, the people easing in streets,

all these could be locally studied. The overuse of the available space and the hazard could be locally studied. In order to help the learning of the local environment of a town, answers could be found for the following questions:

(1) What are the physical environmental features of the town?

(2) How far have they helped in the development of the town?

(3) Is there proper drainage in the town?

(4) What is common landuse pattern of the town?

(5) If there are industries, what is the nature of the industry?

(6) What are the industrial wastes and where are they thrown?

(7) Do they have any effect on the neighbourhood?

(8) Is the city development having any problems like traffic congestion, water problem, availability of houses for nominal rent, etc.?

(9) Is there any encroachment of the human activity over the cultivable land which has brought about the change in the environmental function?

(10) Is there sufficient resource available for further development?

(11) Are the resources overused, that there is a fall in a particular function?

While finding the answers for such questions the local environment of the town area will be studied with the problems.

In order to study the local environment of a big city we may have to study still more complex functions. The big city or urban environmental study will have to magnify the air pollution, energy pollution, noise pollution, pollution by solid wastes, pollution by pesticides, etc. The big cities would be classed as urbanized cities or metropolitan towns.

The study of local environment of an urban area needs not only the observation of the facts that are visible but also the invisible or abstract facts. For example a city may be an industrial city developed along the coastal region like Calcutta. Here the river is also another noteworthy physical feature. So to observe these it will be easy but the sewage water being diverted into the river has to be abserved carefully. The population is more and the interaction with the environment is also greater. The industry and its wastes being dumped could be easily seen and studied, but the wastes in the form of water or chemiclas have to be studied only through the effect they have brought on the other factors, such as the fish along the coast becoming unpalatable or extinct. The water may be with all oil suspension. The coastal sand may change in colour by soot emitted from the industries. The sky mogt of the time will be obscured by the smoke emitted from these. During the cold season the smog with uncomfortable life will be felt and studied. The urbaniztion has drawn so much pupulation into it from the neighbouring villages the number of houses go up and the area occupied by each house stop within the size of a room. This movement of the people creates permanent congestion in the streets as pedestrians and vehicles. The development of transport and transport lines have given rise to accidents, a common feature. The domestic wastes do pollute the air. The other pesticides, used to protect water, crops etc. themselves may lead to health hazards. The open park will be only a few in number. This in course of time reduces the healthy fresh airy spots within the urban area. The need being more, the available resources are overused or misused. The inclusion of the neighbourhood makes the people change their occupation from agriculture to urban occupation. The production output will be neglected. The congestion is created more in the urban centres. These people will form the slums in between their work places, namely factories, wholesale commercial units etc.

The change in transportation lines and functions could be studied. The roads are slowly broadened with pavements. In course of time the roads with separate path for up and

down traffic, for cyclists and pedestrians are being sectioned which is the reflection of the development of the place. New routes will be introduced within the city limit and to all the newly developed residential areas and the newly established work spots. In metropolitan regions, the development and utility of resources are so much that constant daily clearing of the place is essential, as the wastes of various types pollute the atmosphere in no time. Air pollution from automobile, factories, houses are easily seen. The others are the accumulation of dirty water, perishable wastes, which pollute the air by bad odour and discomfort, to live there. The bus functions have given rise to noise pollution. This has shifted the residents to calm and less noisy areas. Water pollution by use and misuse of water and careless outlets of water wastes into public places harm the local people. (Terms : Urban and metropolitan town have also been used for big cities).

The following questions can form as basic material for the purpose of getting answers to sum up the environmental problems of a city :

1. What are the different land uses of the city ?
2. What are the physical features ?
3. Where are the industries located ? Ar e the industrial wastes in the form of solid wastes or water ?
4. Where are they thrown ? Have they given rise to any discomfort to the locality ?
5. Is there any notable health hazard reported ? Is the sky always clouded with smoke ? Is there specific discomfort felt by the people in the area during cold seasons by smog ?
6. If it is near the coast is there a change in the physical appearance of the water along the coast ? Is there any change in the marine living things ? Is there any particular disorder created by the consumption of fish caught in this place ?
7. Is there any increase in the residential area in the city limit itself ? Has it any effect on the already existing

drainage system? Is the sewage water flowing without the public system overflowing during rainy season?

8. Are they traffic jams at all busy road junctions? Do you see new one way traffic routes being introduced often? Is there separate path for the cyclist, in subways and flyovers built?

9. Are there any new recreation centres being established?

10. How are the wastes disposed?

11. Is there any particular health hazard reported in the areas of industry?

12. Is there any other discomfort being repeatedly reported by the local people?

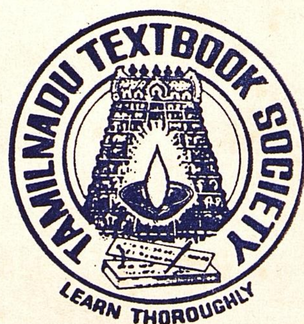
The answer to these questions will help the study of the local environment and tits problems, of a metropolitan city.

Whatever be the local environment whether a village, town or city, it has its own development and problems. There are environmental legislation formed for all the various environmental aspects and problems. They have framed certain rules upto which the environmental development is permitted and excesses are being treated accordingly. Proper planning methods are suggested. For example the plan is set up to cover the total geographic area in question. This planning will have to be applicable simultaneously to all land use circulation patterns, and economic interactions. Logical and workable planning units are delineated. Long range consequences are examined and considered in the light of short range needs.

These efforts to overcome problem, the planning should be effectively handled. As it concerns the local community who have created the problems to satisfy their needs, careful tactics have to be used to convince them before taking action. The intense problem areas have to be zoned first and then the particular cause for the problem be made clear to the people and then solved. For example the wholesale com-

mercial activity at the core of Madras city has created so much environmental problems, that the planners had to prepare the sellers and convince them about their continuous facility for transaction even at the proposed place of shift. Only after a lot of continuous preparation they are slowly moving the activity. Another step is to enhance the tax on urban uses and by reducing the taxes on agricultural lands which will stop the city developing into neighbourhood and hindering production on those lands. The industries and the industrial wastes which are creating ecological crisis are prevented from further damage by canceling the extension of licenses. Even those who apply for new licenses are given only if they execute a declaration that the environment will be preserved as it is even after their industry starts functioning. A good examble is the action taken in Japan, where the industrialization leads to diseases, water pollution, extinction of marine wealth, the industrial water creating a biotic change in the fish which crippled the people who consumed them. They had to restrict the licenses to overcome this problem. Some people do misuse the natural resources which create problem in the overuse of resources not for full utility be any product taken fron nature is partly used and the other, parts though useful but not to this particular industry, are thrown as waste. In course of time the dearth of that resource will create economic problem. In such cases strict administrative rules are framed to punish those who waste the natural resource. In the villages the open ponds are contaminated by multiplc uses. This could be prevented by securing the water sources as per need. The agricultural lands being used for other purposes and over cultivation with an aim to get more income, and not considering the capacity of the land and soil may be punished.

On the whole whatever bc the locality, they provide ample aspects of environment for study and the realisation of problems be brought out. This will help the need to prevent the problems or take proper action to overcome them so that man's interaction with the local environment will not lead to eco-crisis.


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